THE FOSSILS OF THE INDIANA ROCKS, NO. 3.

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GENERAL REMARKS.

One of the most important formations in the State of Indiana is that which is known by the name of Coal Measures; a name which was applied to the corresponding formation in England in the early history of geology. Whatever of signification the name may have originally had, it is now used as a proper name of a geological formation, just as the names Niagara, Hamilton, Corniferous, etc., are used for other formations. The great Carboniferous system of rocks is known to exist over a large part of the two Americas, and large parts of Europe and Asia also. It probably exists in other divisions of the earth, but in those just named it has been more or less extensively studied.

The strata of the Carboniferous system are usually separated into three divisions, namely, the Lower Carboniferous (or, as it is sometimes called, Subcarboniferous), the Coal Measures and the Permian. The Lower Carboniferous strata are well developed in Indiana; and some of the most interesting fossils that have been found in the State come from that formation. In the States to the westward of Indiana, the Lower Carboniferous series has been divided into five distinct groups, each being characterized by fossils which are peculiar to its own strata. The greater part of these groups are recognized within the State of Indiana, and have received much attention from geologists and paleontologists, on account of their interesting geological features and the richness of their fossil remains.

The Coal Measures are, in like manner, divided into three groups or subdivisions, under the respective names of Lower, Middle, and Upper Coal Measures, the latter being sometimes called Permo-Carboniferous. The lines or planes of demarkation between these three subdivisions of the Coal Measures are not so distinct as they are between the subdivisions of the Lower Carboniferous series; neither are they so distinctly separated from each other by the character of their respectively contained fossils.

In consequence of this similarity of the fossils contained in the Coal Measure series, some geologists are not disposed to recognize the subdivisions that have been named as anything more than a convenience of arrangement for study and description. Many geologists also seriously question the existence of the Permian formation in any of the States which lie to the eastward of the Mississippi River; and, so far as any information is concerned which may be furnished by invertebrate fossils, the question is still an open one. Professor Cope, however, has described some important vertebrate remains from Vermillion county, Illinois, which he regards as clearly indicating the Permian age of the strata from which they were obtained.

In this article, I shall treat only of the fossils of the Coal Measures, and I shall confine myself to the invertebrate forms, omitting, entirely, all vertebrate forms and plants. Before proceeding with the description of these fossils, I will, in compliance with the often expressed wish of Professor Collett, present some popular remarks of a general character which have a bearing upon the subject of this article.

To properly understand the subject of any special investigation in Paleontology, one must carefully inquire into the physical conditions which existed at the time the fossil forms he studies were living ones; and this may be done with more satisfactory results than many may suppose. It is not strange, that those who are not accustomed to geological investigations often think such efforts are necessarily profitless, nor that they should sometimes regard any statements which may be made with reference to the physical conditions that existed upon the earth at a time so remote as the Carboniferous age as amounting to nothing more than vagaries of a vivid imagination, or that they are, at best, mere speculations as to what conditions may possibly have then existed. It is true that we can not now know what the physical conditions were which prevailed during any former period of the earth's history with the same minuteness that we know the conditions now existing, but nothing is more certain than that we may know what some of those conditions were with approximate accuracy. Taking the present conditions which prevail upon the earth as a key to the past, we are able to reach conclusions which, for extent, variety, and evident accuracy, would have startled us at the outset. Let us consider, briefly, a few examples of the methods by which geologists reach their conclusions with reference to physical conditions which prevailed during past geological ages.

The most northerly point in American seas at which true reef-building corals now exist is in the vicinity of the Bermuda Islands. The waters of the sea to the northward of this are, except perhaps in the deepest waters, too cold to allow the existence of coral-forming polyps.* Further-

* Since this paragraph was written, the labors of the U. S. Fish Commission have demonstrated the existence of a considerable variety of corals in the deep sea in much higher latitudes; but this does not materially affect the application I make of the facts mentioned.

more, coral-forming polyps are found only in marine waters, never in fresh waters. In all the geological periods, however, which are represented by the formations of Indiana, of whatever age, coral-forming polyps existed, and, in the strata which represent those periods, fossil corals are now found. We infer, therefore, that the waters in which all the formations of Indiana were deposited (with the exception of the beds of coal and some of their immediately associated layers) were of marine saltness, and probably as warm as those of the Florida Keys. Furthermore, formations of the same geological age as some of those of Indiana are found within the Arctic circle, containing, in both regions, fossil corals of the same or closely related species. Similar forms of fossil corals are also found in various parts of both the eastern and western hemispheres, and on both sides of the equator. We, therefore, infer that the conditions of climate upon the earth, in those ages, were very different from those which now prevail, and certainly much more uniform. Again: We find imbedded in certain of the strata within the Arctic circle, where no trees can now grow on account of the coldness of the climate, remains, not only of a great variety of forest trees, but, also, many vegetable forms that are closely related to living tropical or subtropical species. We infer from these facts, that there has been a time when the climate within the Arctic circle was milder than the present climate of Indiana.

By the study of the aqueous life now existing upon the earth, naturalists find that certain genera, families, orders, and even classes, of animal forms are restricted to marine waters; that is, to those which have a saltness equal to that of the ocean. Other forms, again, are found only in brackish waters; and still others only in waters that are wholly fresh. When, therefore, we find any fossil remains that come under either of these three categories, we feel confident that we know, approximately at least, whether the waters in which those animal forms lived were salt, brackish or fresh, although long geological periods have elapsed since the last of those forms was living and since those waters gave place to dry land.

Again, certain forms of mollusks are now found living only upon the land, and others mainly or only in marshy places. In case, therefore, of the discovery of fossil shells like those of the first-named kind, we infer that the land upon which they lived was near by, and that the shells were drifted into the waters in which the deposits which now contain them were made. In the case of the other forms, it is legitimate to infer that they were entombed where they lived; and the associated conditions and contents of the strata will tell, with approximate clearness, whether their habitat was a marsh or a lake. In a few instances, discoveries of fossil land shells have been made which were mingled in the same strata with those of true marine mollusks. The inference, in those cases, was plain, and associated

circumstances confirmed it, that the strata in which these fossils were found were deposited in the sea and near the shore, that the land shells were washed into the sea by land drainage, drifted out, sunk, and were entombed with the shells of those mollusks which had lived and died in the waters there. The sediment which entombed them was hardened into rock, the sea receded by the gradual elevation of the land, and now, in the heart of a continent, the geologist's hammer lays bare these ancient forms, and he reads a history which had lain, as in a sealed book, for ages.

By the study of marine life, naturalists also find that certain mollusks and other animal forms inhabit deep, and others shallow, waters. Others, again, are known to thrive in waters charged with sediment; while certain forms can exist only in the clearest water, and are instantly killed by the accession of sediment. Similar distinctions are recognized by paleontologists among fossil forms, and the character of the material of which the strata are composed usually agrees with such determinations; that is, the character of the rocks which enclose the forms corresponding to deep sea life indicates a finer condition of the sediment than that of the wave-washed shallow water deposits. It is no uncommon thing to find among the strata of a formation evidences of the local destruction of life by the irruption of sediment into waters which had long previously been clear.

Since all stratified rocks have been deposited under water, the various formations, when first deposited, were, of necessity, approximately level. When, therefore, we find the formations tilted so that the strata stand at any considerable angle with the horizon, we necessarily infer that they have become so tilted by a subsequent movement of the earth's crust at that place. This tilting of the strata may be so slight as not to be discernable to the eye at the limited exposures which the prevalent overlying soil allows. In such cases, it is only discoverable by traversing the region in which the strata in question occur, and, finding them to gradually disappear beneath another formation, or, finding still another formation, to come gradually to the surface from beneath the one upon which our observations began. In other cases, the strata are found tilted at a high angle, or flexed up against a mountain side, and often entering largely into the structure of mountains. In all such cases, it is needless to say that these movements of the earth's crust took place after the strata so disturbed were deposited, but the use geologists make of this obvious fact is important. For example: It is well known that strata of the Carboniferous age enter largely into the structure of the Allegheny Mountains, and, as the greater part of these strata were formed beneath the level of the sea, it is clear that the entire elevation of those mountains took place after the close of the Carboniferous age. Indeed, certain other facts are now understood to point to a very much later date for the origin of the elevation of those mountains than the close of the Carboniferous age. Again, Cretaceous and Tertiary strata are strongly flexed up against the

ranges of the Rocky Mountain system, and in some places they enter largely into the structure of those mountains. It is, therefore, plain that the Rocky Mountain system had no existence prior to the close of the Cretaceous period or the beginning of the Tertiary. Mountains are by no means the stable objects they seem to be in comparison with the shortness of human life and human history, and it is probable that many mountains and mountain ranges have risen upon, and disappeared by erosion from, the face of the earth in former geological times, but it is practically certain that all the present mountains of the earth were formed since the animals lived whose remains are described upon the following pages.

These remarks will serve to indicate the methods by which geologists reach the conclusions they put forward. While many of these conclusions are full and satisfactory, it is not to be denied that many important problems still await solution; and that, in many cases, the order of past events is obscure or the geological record of them is abruptly broken. Considering the circumstances, however, the minuteness and accuracy of the geological history which has been read in the rocky strata of the earth are truly surprising. While the student of the physical geography of the present day defines the features of the earth as they now are, the geologist catches here and there, through the ages that have passed, a multitude of glimpses of the features that our old earth has put on and worn for a time, and then laid aside; of broad seas whose boundaries were far from those which are known to modern geography, and whose waters teemed with strange forms of life; of the rise of continents, where once were only islands or a shoreless sea; of mountain ranges that rose in grandeur, and then slowly wasted away to their very bases by the corroding action of the elements; of broad regions covered with verdure and peopled with a wonderful wealth of animal life. With these hints concerning the methods of reasoning adopted by geologists, I may now present some remarks concerning the physical conditions which are thus understood to have prevailed during the Carboniferous age and while the animals were living whose fossil remains are described on following pages.

When the name "Carboniferous" was first chosen for the great system of stratified rocks that succeeds those of the Devonian age, it was supposed that all the mineral coal of the earth was contained within it, and the name was chosen in consequence of that opinion. A coal-like substance, called lignite, was then known to exist in comparatively small quantities in different formations of much later geological age than the Carboniferous; but these deposits were regarded as unimportant and the coal was believed to be inconsiderable in amount. The idea then prevailed that during the Carboniferous age, peculiar conditions existed for the abundant growth of vegetable life such as the earth never

knew before and has never known since. As our knowledge of the geology of the earth has increased, however, so much coal has been found in strata other than those of the Carboniferous age, that it has become a question whether more than half of the known coal of the earth is referable to that age. All the coal of the numerous and important mines that have been opened in western North America, west of the 100th meridian, is obtained from strata none of which are older than the Cretaceous period; and its origin is, therefore, of much later date than the close of the Carboniferous age. It is now, also, known that immense quantities of coal of much later origin than the Carboniferous age exist in other parts of the world, notably in China. The following extract from a chapter by the eminent geologist, Dr. Newberry, in Pumpelly's Geological Researches in China, Mongolia, and Japan, presents this fact in a clear light: "We have, of course, no right to assume that no Carboniferous coal exists in China, for it may very well happen that, as in our own country, coal seams of economic value, but of different ages, will be found there at points not greatly removed from each other. But geologists will not fail to be deeply interested in the fact that so large portions of the coal basins of China, including beds of both antharcite and bituminous coal—worked for hundreds of years, probably the oldest coal mines in the world—are wholly excluded from the Carboniferous formation. So large is this coal-bearing area, indeed, that, when joined to the Triassic, Cretaceous, and Tertiary coals of North America, they quite overshadow the Carboniferous coals of Europe and the Mississippi Valley, and suggest the question, whether the name given to the formation which includes the most important European strata has not been somewhat hastily chosen."

Moreover, there are large regions in different parts of the earth where the strata of the true Carboniferous age, known to be such by the character of the fossils they contain, are found to contain no coal. Still the name "Carboniferous"—coal-bearing—remains as a proper name for this system of rocks, wherever it may be found, although its strata may contain no coal; and even though strata of another geological age in the same region may contain an abundance of coal. These facts make it clearly apparent that the mere presence of coal in any strata, is, of itself, no indication of their geological age, and it will, therefore, be readily understood that the only true indication of the geological age of any formation is furnished by the fossil which it may contain. Hence, the importance of paleontology in the study of the geology of any region.

As regards the coal of Indiana, it all belongs to the true Carboniferous age, and no strata of the geological age of those which contain the coal of western North America exist in this State. In the further discussion of this subject, therefore, I shall have reference to strata of the Carboniferous age alone.

Those who have studied the fossils of the Mesozoic and Tertiary periods

—that is, the geological periods which succeeded those of the Carboniferous age—are familiar with the fact that there is great diversity of the species of those fossils in the various regions of the earth; that is, the number of species belonging to any given one of those periods which are found in more than one of the grand divisions of the earth, is very small, and a large proportion of the species are apparently confined to a small area. In the case, however, of the fossils which characterize the Carboniferous age, we find many of them to have an almost world-wide distribution. For example, several of the species which occur in the Coal Measure rocks of Indiana are not only found in other and widely separated parts of our own country, but they occur, also, in the Carboniferous strata of South America, Europe, and Asia. This fact indicates that a far greater uniformity of conditions then existed all over the earth than existed in the subsequent periods, or than exists at the present time; that is, the conditions were sufficiently alike in different parts of the earth to allow of a great uniformity of animal life. But since coal is found in only a part of the whole series of strata which make up the Carboniferous system, and in certain regions coal does not exist at all among its strata, although the characteristic fossils are there, it is plain that the precise conditions which resulted in coal making were not everywhere uniform. Indeed, it is certain that in large portions of those regions of the earth within which deposits of stratified rocks were produced during the Carboniferous age, no coal whatever was produced. It is, also, true that within those areas where coal-forming material was accumulated, the conditions favorable for its production alternated with unfavorable conditions, so that beds of coal alternate with beds of limestone or sandy and clayey layers.

Coal is unquestionably of vegetable origin; and, although traces of vegetable structure are not always distinguishable in it, fragments of plants like those which contributed to its production are found scattered in the layers which are associated with the coal beds. Alternating with the coal beds are strata composed of sandy and clayey shales, together with limestones and sandstones, which strata make up the great bulk of the Coal Measures. These strata contain the fossil remains which characterize the formation. In some of the layers, as before stated, remains of plants are found; but, in others, fossil shells, corals, etc., prevail, sometimes abundantly. It is plain that the plants must have grown upon the land, and that the animals which formed the shells and corals lived in the waters in which the strata were deposited, and their characters show plainly that those waters were marine. The abundance of vegetable matter that it must have required to produce such extensive beds of coal, the character of the coal beds, and their freedom from extraneous substances, and the character, also, of some of the associated strata, show that the vegetation in question grew upon the very surfaces upon which we now find their remains in the form of coal. The character of the

vegetation whose remains we find, that of the material composing the layers which enclose them, and that of some of the animal remains which those layers also enclose, show that the coal-producing vegetation grew in immense marshes, only slightly raised above the level of the sea. It is hardly to be questioned that coal was in the condition of peat in the first stage of its production, and that this peat was produced, as peat always is, by the partial decomposition of vegetable matter under water, or in a state of constant moisture.

Now, these conditions being understood, the following conclusions necessarily follow: In every region that is now a coal field there were, during the period in which the material was produced of which the coal was formed, oscillations of the earth's crust; that is, there were gentle and wide spread risings and sinkings of the crust, in consequence of which the land surface remained for a long time just above the level of the sea; then, sinking, it remained for a long time beneath its level. These risings and sinkings were repeated as often as there are separate beds of coal, however thin or economically unimportant they may be. While the land surface was just above the level of the sea in the Carboniferous age, vegetation grew most luxuriantly, and, from its debris, peat beds of enormous thickness and extent were formed. When the land gradually sank again beneath the sea level, these peat beds were covered with sedimentary material, which afterward, as the ages passed, became changed to the condition of shales, sandstones, and limestones that we now find them to be, and the peat became changed to coal. We find those shales, sandstones, and limestones charged with fossil remains of such a character as to show that both they and the strata which enclose them are of marine origin.

Such is a statement of the leading features of the conditions which prevailed during the coal-forming period of the Carboniferous age. Such conditions prevailed over a large area which is now included in the North American continent, and of which a large portion of Indiana now forms a part. As before stated, the coal-making conditions did not prevail everywhere during the Coal Measure period; but they occurred in circumscribed, yet very extensive, areas. It is believed by geologists, that the great area in which the coal of Indiana was deposited once extended from eastern Pennsylvania to beyond the Missouri River, and from Michigan to the northern portion of the Gulf States. Coal has been found among Carboniferous strata as far west as eastern Nebraska and Kansas, but with insignificant exceptions, it has never been found in any strata of the Carboniferous age to the westward of that region, although the aggregate thickness of the strata of the Carboniferous system is very much greater in that far western region than it is anywhere east of the Missouri River. In that western region, the strata are almost wholly of marine origin; and as they consist almost entirely of sand-

stones and limestones, without coal or carbonaceous shales, it is plain that conditions favorable to the abundant growth of vegetation did not exist there in any portion of the Carboniferous age. That is, while the coal-plant forests of the eastern portion of the continent were growing luxuriantly, the unbroken sea prevailed over what is now the western portion, or at least over that part of it which is found to be occupied by Carboniferous strata. In those western marine Carboniferous strata very many of the fossil species are identical with those which are found in Indiana, in strata which alternate with beds of coal. We, therefore, infer that while those portions of Indiana which are now occupied by the Coal Measures were beneath the level of the sea, the waters which submerged them were continuous to that far-off western region. Indeed, as I have before shown, it was doubtless then continuous, also, over a large part of the earth.

Now, let us inquire as to the character of the life that existed during the time within which the Coal Measures of Indiana were formed, and within the area which now constitutes the great coal field of eastern North America. If, during that period, there were mountains upon any part of what is now the North American continent, they were far to the northward and northeastward; at least, it is certain that none of the mountains that now make up either of the great mountain systems of North America then existed. During that portion of the long Carboniferous age, when and where the land was above the level of the sea it was clothed with a luxuriance of vegetation, such, perhaps, as the earth has never witnessed at any other period of its history. Trees of strange form sent up their towering trunks above the dense undergrowth, but no birds perched in their branches, nor waded the marshes or swam in the pools among them. A few reptiles and batrachians lived there, but reptilian life seems not yet to have gained much of a foothold upon the earth, especially compared with it as it afterward became. None of the mammalia, the chief forms of the animal life of the present day, had yet come into being so far as we yet know. Insects and Myriapods lived then, and, probably, in great abundance, for their means of subsistence abounded in the bountiful vegetation, and their natural enemies were remarkably few. The earth was then a great solitude, and the reigning stillness was perhaps broken, in the intervals of storms, only by the hum of insects and the bellowing of frog-like batrachians. Where the sea prevailed during all this long period, its waters teemed with life. Fishes were there; some of them large and powerful, but all were unlike the scaly fishes of to-day. Mollusks in great abundance, and corals of delicate beauty existed; and a diversity of crustaceans nestled and sported among the seaweeds or crept along the oozy bottom.

Coal-making conditions did not apparently begin with the beginning of the Carboniferous period. The earliest known coal beds were not

formed until near the close of the Lower Carboniferous period, and at a time when fully one-third of the great Carboniferous age had passed; and the coal-making condition was not fully established until the middle, or Coal Measure, period of that age. Marine conditions, apparently, alone prevailed during the Lower Carboniferous period. Its fauna was similar to the marine fauna of the Coal Measure period—a portion of the fossil remains of which are figured on plates accompanying this report.

The foregoing remarks are intended to convey to the general reader an idea of the character and significance of the fossil remains I shall describe on following pages. It would require a series of volumes to illustrate all the forms that are now known to have existed during the Coal Measure period alone. In this article I shall necessarily confine myself to a consideration of the fossil shells, corals, and crustacean remains that have been found in the Coal Measure strata of Indiana and those of the adjacent States. I have aimed to select those only which may be reasonably looked for in Indiana, but far the greater part of them have actually been found in its strata. Many of the figures have been borrowed from works previously published, but they are nevertheless correct representations of forms that exist in the strata of Indiana and representatives of the ancient life of a region of which this State now forms only a small part.

FAUNA OF THE COAL MEASURES.

DESCRIPTION OF SPECIES.

PROTOZOA.

The *Protozoa* are not very numerous in the Coal Measures of the United States, or, at least, they are not conspicuous objects to the general collector. Protozoan life doubtless abounded during the Coal Measure period, but the calcareous shells of the Foraminifera appear to be the only forms that have been preserved. The only conspicuous species (or the only one which is likely to attract the attention of the general collector) is the one which is described in the following paragraphs.

FORAMINIFERA.

Genus FUSULINA, *Fischer.*

FUSULINA CYLINDRICA, *Fischer.*

Plate 23, *figs.* 1, 2 *and* 3.

FUSULINA CYLINDRICA. Various European and American authors.

Shell small, varying in shape from elongate-fusiform to subglobose, and, also, varying greatly in size; the extremities usually somewhat prominent,

even in the subglobose forms, and have the appearance of being somewhat twisted; surface marked by five longitudinal furrows, which mark the position of the septa, and which are straight, except that they are a little flexed at the ends; aperture very small, and usually obscured by the imbedding rock; volutions six to ten in number, closely coiled, the interspaces narrow; septa from twenty to thirty or more in the outer volution, undulating along their inner edge; the foramina of the septa, or foramen apertures, moderately distinct in specimens that are well preserved.

The common size and shape of specimens of this species is closely like that of a grain of a wheat, but they are often found very much smaller,* and sometimes larger and longer, and both more slender and more globose.

This interesting form is not only common in the Carboniferous rocks of various parts of Europe, but it is found in the Coal Measure strata of the United States, from Ohio to California. It may be sought for at Lodi, Fountain county, Indiana, in the limestone roof of coal K.

CŒLENTERATA.

POLYPI.

As a large proportion of living Polyps form no coral skeletons, it may be inferred that many kinds of Polyps existed in the Coal Measure and in other geological periods, which have left no trace of their existence in the rocks which represent those periods. In strata of some of the periods fossil corals are abundant, but, although a considerable number of widely differentiated forms are found in Coal Measure strata, they are seldom found to constitute a conspicuous feature of the fossil fauna of that formation. I herewith present descriptions of five species of fossil corals, all of which are more nearly related to forms which existed in the previous geological formations than they are to any that are now found living.

Genus ZAPHRENTIS, *Rafinesque.*

ZAPHRENTIS GIBSONI (sp. nov.)

Plate 23, *figs.* 4 *and* 5.

Corallum curved, conical in form; its outer surface marked by concentric lines and numerous strong wrinkles of growth, and also by numerous distinct longitudinal raised lines; calyx subcircular, deep, and its edges thin; septal fosset well developed, and situated at the concave side of the corallum; septa thirty-six to forty in number, prominent, and thin within the calyx.

Length, along the longest side, 32 mm.; diameter of the calyx, 25 mm.

This is plainly a typical species of *Zaphrentis*, and, so far as I am aware, it is the only species of that genus which has been found in the true Coal

*In Indiana, it is rarely larger than half the size of a grain of wheat. C.

Measures of the United States, although the genus is well represented in the Lower Carboniferous. It resembles in shape *Z. spinulifera*, Hall, from the Lower Carboniferous limestone, but it is without spines, its proportions are somewhat different, and the calyx is deeper.

Locality. The specimen herein described and figured was obtained from the Coal Measure strata of Vermillion county, Indiana, by Mr. William Gibson, in whose honor the specific name is given.

Genus LOPHOPHYLLUM, *Edwards and Haime.*

LOPHOPHYLLUM PROLIFERUM, *McChesney.*

Plate 23, *figs.* 6 *and* 7.

Corallum subconical-elongate, more or less curved; more or less irregular in form; base slender, usually pointed; epitheca thin; concentric lines and wrinkles of growth distinct, especially the latter; longitudinal striæ distinct; a few spinules sometimes observable near the slender base; calyx subcircular, moderately deep; columella strong, prominent, compressed so that its longer axis is in the plane of the curve of the corallum; septa varying in number with the size of the corallum, from about thirty to nearly or quite fifty, each alternate one much less prominent than the others, the latter extend to the columella, near which they are usually a little flexed.

Different specimens are variable in proportions; a common size is 18 or 20 mm. long and 10 mm. across the calyx.*

This species is a very common one in the Coal Measures of Indiana, Illinois, and Iowa. A more slender form than the one here described occurs in Illinois and Indiana, to which Professor Worthen has given the name *Cyathaxonia distorta.* To a larger and more robust form I have given the name *Lophophyllum sauridens.*

Locality. Common throughout the Coal Measures.

Genus AXOPHYLLUM, *Edwards and Haime.*

AXOPHYLLUM RUDIS, *White and St. John.*

Plate 23, *figs.* 8 *and* 9.

AXOPHYLLUM RUDIS, *White and St. John*, 1867. Trans. Chicago Acad. Sci., I, p. 115.

Corallum irregularly turbinate, more or less contorted; attached at the apex or along the greater part of its length, usually expanding rapidly from the apex to the calyx; surface marked by irregular concentric undulations of growth, by faint longitudinal lines which indicate the position of the septa, and often by more or less numerous irregular rootlets; outer portion of the calyx shallow, central portion moderately deep; columella small, somewhat prominent, flattened.

*Indiana species are three or four times as long as wide. C.

The size of the specimens is somewhat variable. An example of ordinary size measures 20 mm. in length and 12 mm. across the rim of the calyx.

This species is not uncommonly met with in the Upper Coal Measures of Indiana, Illinois, and Iowa. It is sometimes found as a single simple corallum, but it not unfrequently occurs in clusters, which have originated from a parent corallum by lateral gemmation; and the new corallums are often more or less bound together by their rootlets.

Locality. The specimens figured are from Newport, Indiana. These are rather smaller than the average size.

Genus CAMPOPHYLLUM, *Edwards and Haime.*

CAMPOPHYLLUM TORQUIUM, *Owen.*

Plate 23, *figs.* 10, 11, 12 *and* 13.

CYATHOPHYLLUM TORQUIUM, *Owen*, 1852. Geol. Sur. Wis., Iowa and Minn., plate IV, fig. 2.
CAMPOPHYLLUM TORQUIUM, *Meek*, 1872. U. S. Geol. Sur. Nebraska, p. 145, pl. I, fig. 1.

Corallum simple, moderately large, having one or more abrupt flexures in the first five or six centimeters of its length; but, beyond that, it is subcylindrical and approximately straight when full-grown; epitheca thin; surface marked by concentric lines and numerous wrinkles; calyx subcircular, shallow at the outer portion, but deepening abruptly at the middle; margins of the calyx thin; a moderately distinct septal fosset is observable at the side of the calyx, near the convex curve of the corallum; primary septa from thirty to fifty in number, extending a little more than half the distance from the margin of the calyx to its center, moderately strong; secondary septa short, thin, and inconspicuous; tabulæ very wide, occupying about two-thirds the full diameter of the corallum, somewhat irregular, but all arching a little upward; dissepiments forming a multitude of small oblique vesicles between the radiating septæ.

Large examples reach 150 mm. or more in length, and have a diameter of 35 or 40 mm.; but the ordinary size is less.

This coral has hitherto been found only in the Upper Coal Measures or Permo-Carboniferous strata. It is common in Iowa, Missouri and Nebraska, is known in Illinois, and is likely to be found in Indiana in Sullivan and Vigo counties, on and west of the Wabash.

Genus MICHELINIA, *de Koninck.*

MICHELINIA EUGENEÆ (sp. nov.)

Plate 23, *figs.* 14, 15 *and* 16.

Corallum usually in the form of a small globular or irregularly ovoid mass, higher than broad, with the corallites usually opening upon all sides, except its very small base, which is often concave and irregular;

corallites small, but very irregular in size and shape; calyces moderately deep, their walls rather thin and margins narrow or even sharp.

Height of one of the larger masses in the collection 26 mm.; transverse diameter of the same, 17 mm. Diameter of the larger calyces, 3 mm.; of the smaller ones, 1 mm.

Usually the calyces cover the whole outer surface of the corallum except the small base, which was evidently attached to some foreign body; but occasionally a considerable surface above the base is free from calyces and is covered with a wrinkled epitheca. This is the only species of *Michelinia*, so far as I am aware, that has ever been found in the Coal Measure strata of North America, although two or three species are known to exist in the Lower Carboniferous rocks. It is likely that the *Favosites Whitfieldi*, White, from the Kinderhook group at Burlington, Iowa, will prove to be a species of *Michelinia*. If so, it somewhat resembles the form here described in the smallness of the corallites, but not in the shape of the corallum.

Locality. Edwardsport, Knox county, and Eugene, Vermillion county, Indiana, and one or two localities in Illinois.

BRACHIOPODA.

The *Brachiopoda* are among the most abundant and characteristic fossils of the Carboniferous rocks. At the close of this age, a large proportion of the genera, and also some of the families that flourished in this and the preceding age, ceased suddenly to exist. In all the rocks of Mesozoic and Cenozoic age, and also in existing seas, Brachiopods are among the least abundant of shell-bearing animals.

Genus LINGULA, *Bruguiere.*

LINGULA UMBONATA, *Cox.*

Plate 25, *fig.* 14.

LINGULA UMBONATA, *Cox*, 1857. Geol. Sur. Kentucky, vol. III, p. 576, pl. X, fig. 4.

Shell subelliptical in outline, a little narrower behind the mid-length than in front of it; the sides broadly convex; anterior and posterior ends both rounded; the body of the shell gently and somewhat regularly convex, but the umbo narrow and more prominent; beak narrow, minute.

This shell is evidently identical with the *Lingula umbonata* of Cox, although the flattening along the middle is not so distinct as it is represented to be by his figure.

Locality. Cox's specimens were obtained in Kentucky. Those here described and figured are from Vermillion county, Indiana.

Genus DISCINA, *Lamarck.*

DISCINA NITIDA, *Phillips.*

Plate 25, *fig.* 10.

ORBICULA NITIDA, *Phillips.* Geol. of Yorkshire, II, p. 221, pl. XI, figs. 10-13.
DISCINA NITIDA (Phillips), *Meek and Worthen,* Illinois Geol. Reports, V, p. 572, pl. 25, fig. 1.

Shell small, subcircular, depressed-conical; the sides sloping nearly straight from the apex to the margins; apex prominent, situated at about one-third the diameter of the shell from the posterior border; lower valve flat, with the usual depression around the foramen; surface of both valves marked by concentric lines and fine lamellations.

Diameter of an average sized example about 8 mm.

Locality. This small *Discina* is common in the Coal Measures of Indiana, Illinois, Iowa and Missouri; abundant at Cannelton and Horse Shoe, of Little Vermillion.

DISCINA CONVEXA, *Shumard.*

Plate 25, *fig.* 9.

DISCINA CONVEXA, *Shumard,* 1858. Trans. St. Louis Acad. Sci., I, p. 221.

Upper valve broadly but somewhat prominently convex; sub-circular in marginal outline; the height nearly equal to one-half the diameter; apex somewhat obtuse, but moderately prominent, situated at about one-third the diameter of the shell from its posterior margin; surface marked by the usual distinct concentric lines of growth. A smaller under valve was found at the same locality with the upper valve above described, and probably belongs to this species. It shows a similar surface, which is nearly flat, but it is depressed about the foramen, which is of the usual character; the foramen is situated just beneath the position of the beak of the upper valve.

Diameter of the upper valve, just described, 27 mm.; height, 12 mm.

Locality. Dr. Shumard's specimens were from the Upper Coal Measures of Kansas. Those here described are from Vermillion county, Indiana.

Genus CRANIA, *Retzius.*

CRANIA MODESTA, *White and St. John.*

Plate 35, *fig.* 9, *and plate* 36, *fig.* 5.

CRANIA MODESTA, *W. and St. J.,* 1867. Trans. Chicago Acad. Sci., I, p. 118.

The type specimen of this species was free, and both valves were together in place, but the specimens of this collection all appear to have been attached to some foreign object by the lower valve; the upper valve is moderately convex, and the lower flat; both marked by concentric lines of growth. The only examples in this collection are under valves

attached to other fossils, and, of course, show only the inner surface. Figure 5, plate 36, shows such valves adhering to a fragment of *Orthoceras Rushensis*, and figure 9, plate 35, shows similar valves adhering to a specimen of *Athyris subtilita*.

Locality. Eugene and Newport, Vermillion county, and at Merom, Sullivan county, Indiana.

Genus PRODUCTUS, *Sowerby.*

PRODUCTUS NEBRASCENSIS, *Owen.*

Plate 24, *figs.* 7, 8 *and* 9.

PRODUCTUS NEBRASCENSIS, *Owen*, 1852. Geol. Report Wis., Iowa and Minn., p. 584, pl. V, fig. 3.

Shell of about average size for a species of this genus; outline in front of the cardinal border rudely semi-elliptical; length usually less than the breadth; cardinal border generally a little less in length than the greatest breadth of the shell, and never exceeding it; antero-lateral margins strongly, and front margins broadly, rounded, in the latter sometimes a little emarginate at the middle; postero-lateral margins somewhat straightened upon, and in front of the ears, meeting the cardinal border at a somewhat obtuse angle; ears small, seldom prominent; ventral valve somewhat regularly convex from front to rear, greatest convexity behind the middle; umbo prominent, projecting behind the hinge line; beak prominent, incurved a little over the cardinal margin; a mesial flattening, amounting sometimes, but rarely, to a distinct sinus, extending from the umbo to the front margin; dorsal valve flattened in the visceral region, the antero-lateral and front portions curving abruptly upward; beak and auricular regions depressed so as to produce a slightly raised, rounded, diverging fold between them respectively, at each side; mesial fold seldom distinct and perceptible only at the front; surface of both valves covered with numerous spines of different sizes, but all very small, those of the ventral valve are borne upon more or less distinctly defined concentric folds, and may be divided into two sets or kinds, one consisting of the stronger and more erect spines, and the other of small, short ones, the latter being closely appressed against the surface; both kinds are more or less connected by means of numerous raised radiating lines, which are more apparent upon the concentric folds than upon the surface of the interspaces.

Length, 33 mm.; breadth, 35 mm.

This species is a common one in the Coal Measure strata in the States of the great Mississippi valley, from Indiana westward; and it is frequently found in the Carboniferous strata of the Rocky Mountain region. As it is usually obtained from a limestone matrix, the spines and outer layer of the shell are removed. Such specimens present an appearance so different from that of those which have been perfectly preserved in a soft matrix

that they have been referred to different species, by different authors. See further remarks in connection with the description of the next species.

Locality. Fountain, Vermillion, Parke and Vigo counties, Indiana.

PRODUCTUS SYMMETRICUS, *McChesney.*

Plate 25, *figs.* 1 *and* 2.

PRODUCTUS SYMMETRICUS, *McChesney*, 1866. Trans. Chicago Acad. Sci., I, p. 25, pl. I, fig. 9.

Shell suborbicular in marginal outline, the breadth being a little greater than the length; the cardinal border a little less in length than the greatest breadth of the shell; the lateral margins rounding regularly to the front margin, the latter being broadly rounded; ventral valve moderately convex, without a mesial sinus; ears not distinctly defined from the body of the shell, obtusely angular or rounded at their extremities; beak somewhat prominent, incurved but not projecting much over the cardinal border; dorsal valve moderately and somewhat uniformly concave; cardinal process slender, trifid at the end, the middle division being a little more prominent than the other two; surface of both valves marked by small concentric wrinkles or ridges, which are covered by numerous short minute spines, which are directed obliquely forward, and which are somewhat larger upon the ventral than upon the dorsal valve.

Length, 50 mm.; breadth, 52 mm.; convexity, 21 mm. But these dimensions vary somewhat in different specimens.

This form seems to be worthy of a separate specific designation; but it is not to be denied that it is closely related, on one hand, with *P. Nebrascensis*, and on the other with *P. punctatus*, both of which species are also frequently met with in the Coal Measure rocks of the United States. It is also clearly related to *P. scabriculus* of the European Carboniferous. Being associated in the same formation with the two first named species, and possessing so many points of resemblance in common with each other, the genetic relationship of these three forms would seem to be unquestionable; and yet they possess differences which, for both zoological and geological reasons, it is desirable to recognize. The differences between these forms have been discussed at length by Mr. Meek in Hayden's Report on the Geology of Eastern Nebraska, and in Vol. IV of King's Reports on the Geology of the 40th parallel. In the latter work, he has proposed the new specific name *P. Nevadensis*, for a form that is so closely like *P. punctatus* that it has usually been regarded as identical.

Locality. McChesney's type specimens of *P. symmetricus*, and also the one which is figured on plate 25, are from Coal Measure strata in Illinois; but it may be sought for in Vermillion, Vigo, Sullivan, Vanderburg, Dubois, Warrick and Pike counties, Indiana.

PRODUCTUS PUNCTATUS, *Martin.*

Plate 27, *figs.* 1, 2 *and* 3.

This species is described and figured in this series of reports for 1881, page 373, plate 42, figs. 1, 2 and 3. For the purpose of grouping the Coal Measure fossils together in this report, that description is repeated here.

This is one of the best known species of characteristic Coal Measure fossils, and one the specific identity of which with the European form of that name has never been seriously questioned. The following description applies to the species as it exists in widely separated localities in the United States.

Shell large, test thin; marginal outline varying from imperfectly four sided, the narrowest side being the posterior one, to subovate, sometimes being wider than long, but sometimes longer than wide; cardinal margin almost invariably shorter than the width of the shell at any part in front of it; anterior border broadly rounded, but usually a little emarginate at the middle; sides flattened, by which means the lateral margins are somewhat straightened; ears small; ventral valve broadly arcuate from front to rear, in which direction there is also a broad mesial flattening of the valve, with usually a shallow but somewhat distinct mesial sinus along its middle; umbo prominent, narrow; beak small, incurved, and projecting slightly over the cardinal border; dorsal valve moderately concave; beak, as such, wanting, its place being concave; mesial fold ill defined, there being only a slight mesial elevation of the valve extending along the visceral and anterior portions; surface of both valves marked by rather numerous and regular concentric folds, which are smaller at the beak and borders than elsewhere, upon adult shells, and smaller and more distinct upon the dorsal than upon the ventral valve; interspaces between the concentric folds plain; folds supporting numerous spines of varying size, but all minute and more or less appressed against the shell.

Length of the example figured, which is of adult size, 67 mm.; breadth of the same at the broadest part, about the same as the length.

Locality. Same counties as foregoing.

PRODUCTUS COSTATUS, *Sowerby.*

Plate 24, *figs.* 4, 5 *and* 6; *and plate* 25, *figs.* 3, 4 *and* 5.

The form here described is the one which has usually been referred to the European shell to which Sowerby originally gave the above name. There is, however, much reason to doubt its real specific identity with the European shell, but I am not now prepared to discuss that question satisfactorily.

The shell is of medium size; width greater than the length, measured in a straight line from the hinge to the front border, strongly and deeply

arcuate from rear to front; hinge line nearly or quite equal in length to the greatest width of the shell; ears thin, well defined, and bent slightly downward; free margin broadly rounded, the front being slightly emarginate; ventral valve gibbous and strongly curved, having a broad shallow sinus extending from the umbonal region to the front, producing there the before-mentioned emargination of the front border; beak prominent, incurved, but only slightly projecting over the cardinal margin; dorsal valve flattened or only slightly concave in the visceral region, abruptly curved upward at the lateral and front margins; front showing a very slight mesial fold, corresponding with the broad, shallow mesial sinus of the other valve; surface of both valves, except that of the ears, marked by distinct, more or less unequal, rounded, radiating costæ, with interspaces of somewhat less than their own width between them; costæ generally continuous through the greater part of the length of the shell, but sometimes bifurcating, and occasionally two or more of them may be seen to coalesce and form a single costa of more than ordinary size; crossing the costæ, especially on the posterior half of the shell, and forming distinct reticulations with them, are more or less numerous concentric wrinkles; upon the ventral valve, especially toward the margins and upon the ears, there are usually scattered strong, more or less perpendicular, spines. Some of the shells are apparently nearly free from spines, or have only a few upon and near the ears.

Length, 28 mm.; breadth, 34 mm.; convexity, 18 mm.

This is one of the most common and characteristic species of the Coal Measure fossils of Indiana, Illinois, Iowa, and Missouri, and it is also frequently met with in the Carboniferous rocks of the Rocky Mountain region.

It ranges in the Mississippi valley from the Lower Carboniferous to the Upper Coal Measures. It is closely related to *P. semireticulatus*, Martin (the next species described), but it is a smaller shell, and more coarsely and distinctly costate.

Locality. It has been found throughout the Coal Measures of Indiana.

PRODUCTUS SEMIRETICULATUS, *Martin.*

Plate 24, *figs* 1, 2 *and* 3.

This shell is widely known in the Coal Measures of the United States, and has been generally regarded by authors as identical with the European species to which the name was first applied.

It is a large shell, strongly arcuate; width greater than the length; the length of the hinge line sometimes greater and sometimes less than the greatest width of the shell; cardinal area of both valves very narrow, but distinct; ears thin, more or less prominent, lateral and front borders continuously rounded, the front being slightly emarginate; ventral valve

strongly curved; beak depressed and projecting very little, if any, over the cardinal border; a broad, shallow, obscurely defined mesial sinus in most of the examples, extends from near the umbonal region to the front, giving the shell an indistinctly bilobed appearance; dorsal valve flattened in the visceral region, bent abruptly upward at the sides and front; beak flattened or slightly concave; surface of both valves marked by numerous coarse rounded striæ or small costæ, which are crossed in the visceral region by somewhat regular concentric wrinkles of nearly uniform size, giving that part of the shell a semi-reticulated appearance, which is more distinct in some examples than in others; more or less numerous strong, erect spines are scattered upon the ventral valve, generally arising from the costæ upon the body of the shell and from the strong wrinkles upon the ears, upon which latter part they are usually most numerous.

Length of an ordinary sized example, measured in a straight line from the hinge to the front margin, 45 mm.; width, 60 mm.

The differences between this species and *P. costatus* have already been mentioned. Like that species, this one has not only a wide geographical range, but it is also found, in the Upper Mississippi River region, to range from the Lower Carboniferous to the Upper Coal Measures.

Locality. Common throughout the Coal Measures and often in the Lower Carboniferous.

PRODUCTUS CORA, *d'Orbigny.*

Plate 26, *figs.* 1, 2 *and* 3.

This species was, by Dr. Owen and Prof. Marcou, referred to the South American form described by d'Orbigny, in "Voyage dans l'Amerique Meridionale," under the name *Productus Cora.* Other American authors have, however, given it various names, and of late years it has generally gone by the name given it by Norwood, *P. Prattenianus.* I have, however, lately, had an opportunity to examine some examples which were brought by Dr. O. A. Derby from the South American localities from which d'Orbigny obtained his type specimens. A careful examination of these has left no doubt in my own mind that Owen and Marcou were right in referring our North American form to *P. Cora,* d'Orbigny. Some of the new specific names proposed by American authors were based upon varietal differences, such as the presence or absence of spines and small tubercles scattered over the surface, or the difference in the size of the radiating striæ; but, while I admit the existence of these variations, I do not regard them as being of specific value. The following description is regarded as fairly representing the species:

Shell sometimes reaching a large size; the breadth generally greater than the length; hinge line sometimes longer and sometimes shorter than the greatest width of the body of the shell; lateral and front margins regularly and continuously rounded; ears prominent, thin, and, therefore,

they are generally broken off in the imbedding rock; mesial fold and sinus wanting, but, sometimes, there is an indistinct mesial flattening of the ventral valve; ventral valve somewhat uniformly convex; umbonal region gibbous; beak scarcely projecting over the cardinal border; ears marked by strong wrinkles, which pass inward upon the sides of the valves and become obsolete there, but ending abruptly at the cardinal margin; surface of the valves marked by fine, rounded, radiating striæ, some of which may be traced continuously from the umbonal region to the front, increasing by implantation and occasionally coalescing. A few strong, erect spines are often scattered over the surface of the ventral valve, and the cardinal border always bears a greater or less number of small spines. Although the striæ which mark the surface are always small and slender, their relative size differs very much in different individuals, in some cases being minute and hair-like; in the latter cases, the spines are usually absent from the general surface. One of the examples figured on plate 26, bears the finer striæ, and those of the other two bear the coarser striæ with the spines.*

Locality. This species has a wide geographical and vertical range in the Carboniferous rocks of North America. It may be sought for at the following Indiana localities: Fountain, Vermillion, Parke, Montgomery, Clay, Owen, Pike, Dubois and Warrick counties; also in the Lower Carboniferous.

PRODUCTUS LONGISPINUS, *Sowerby.*

Plate 24, *figs.* 10 *and* 11.

This is another species from the Coal Measure rocks of North America, which has been identified with a European form. It is an exceedingly variable shell, as is evidenced by the large number of synonyms which have been given to it, both in this country and Europe. The form that I here describe and figure is a characteristic one of the Coal Measures of North America, and it is yet a question whether it is correctly identified with the European *P. longispinus.* It is one of the smallest species of *Productus* among the somewhat numerous forms that the Carboniferous rocks afford.

It is much wider than long; the hinge line longer than the full width of the body of the shell; ears prominent, thin, and sometimes a little reflexed, the lateral and front margins forming a rude semi-ellipse, but the front margin is more or less emarginate at the middle; ventral valve gibbous, the more abrupt portion of the antero-posterior convexity being behind the middle; umbo of the ventral valve moderately prominent, the beak projecting slightly over the cardinal margin; mesial sinus broad, and distinct only near the front; surface marked by obscure radiating ribs,

*The Owen Cabinet contained specimens from Indiana, identified by d'Orbigny, and labelled in his own handwriting *P. Cora.* C.

usually obsolete upon the umbo, which are crossed by the usual lines of growth; moderately strong, erect spines are scattered over the surface of the valve (these were originally long, but they are almost always broken off); dorsal valve concave; the median portion slightly raised near the front, corresponding with the shallow sinus of the other valve; surface marked like that of the other valve, except that it is without spines.

Length, 11 mm.; breadth of body portion, 17 mm.; length of hinge line, 21 mm.

Locality. The following Indiana localities have furnished the species here described: Fountain, Parke, Vermillion, Vigo, Sullivan, Knox, Pike, Warrick, Spencer, Posey, Gibson and Vanderburg counties.

Genus CHONETES, *Fischer.*

CHONETES VERNEUILIANA, *Norwood and Pratten.*

Plate 25, *figs.* 7 *and* 8.

CHONETES VERNEUILIANA, *N. and P.*, 1854. Jour. Acad. Nat. Sci., Philad., III, p. 26, pl. II, fig. 6.

Shell small, much wider than long; the cardinal portion extended beyond the sides of the body of the shell, sometimes mucronate; ventral valve convex, bearing a moderately deep rounded mesial sinus which extends from near the beak to the anterior margin, toward which it rapidly deepens and widens; the sinus is usually so distinct as to produce the appearance of two prominent lobes upon this valve; ears somewhat angular and a little reflexed, sometimes obtuse, and in other examples acute and produced; beak moderately prominent; area distinct but narrow, a little wider, however, than that of the dorsal valve; foramen wide; cardinal margin bearing four oblique spines on each side of the beak; dorsal valve concave, and bearing an obtuse mesial fold corresponding with the sinus of the other valve; surface of both valves marked with numerous fine radiating striæ which, with the growth of the shell, increase by bifurcation. These are crossed by a few lines of growth.

Length, 8 mm.; breadth, 12 mm.

Two or three other species of *Chonetes* are more or less common in the Coal Measure rocks, but this one may be readily distinguished by its mesial sinus and the bilobed appearance of the ventral valve.

Locality. Every county in the Coal Measures of Indiana has furnished this species.

Genus ORTHIS, *Dalman.*

ORTHIS PECOSI, *Marcou.*

Plate 32, *figs.* 20, 21 *and* 22.

ORTHIS PECOSI, *Marcou*, 1858. Geol. North America, p. 48, pl. VI, fig 14.
ORTHIS CARBONARIA, *Swallow*, 1858. Trans. St. Louis Acad. Sci., 1, p. 218.

Shell small, sublenticular; outline subcircular or subovate; length and breadth nearly equal, but sometimes the length is a little the greater; front margin regularly rounded or slightly emarginate; hinge line very short, less than half the breadth of the shell; ventral valve having its greatest convexity at the umbo, often flattened a little at the front, but it is always without a definite mesial sinus; beak small, pointed, somewhat prominent, and arched over the small, well-defined area, which is also arched; dorsal valve more convex than the ventral, in old shells, its greatest convexity being behind the middle, generally showing a mesial flattening which extends from the umbo to the front margin; area distinct, but smaller than that of the other valve; beak small, not prominent; surface of both valves marked by fine, close-set, radiating striæ, which increase mainly by implantation, but occasionally by bifurcation; these striæ are crossed by fine concentric lines of growth, and near the front by imbricating lines. The striæ often show small pores upon their backs, apparently marking the position of minute tubular spines which have been removed.

Length and breadth of a large example, each 13 mm.; but the average size is considerably less.

Locality. This little *Orthis* is widely distributed in the Coal Measures from Indiana to Nebraska, and also in the Carboriferous rocks of the Rocky Mountain region. It has been found at the following Indiana localities: Horse Shoe of Little Vermillion and Garrett's Mill, Vermillion counties of Indiana and Illinois.

Genus HEMIPRONITES, *Pander.*

Genus STREPTORHYNCHUS, *King.*

HEMIPRONITES CRASSUS, *Meek and Hayden.*

Plate 26, *figs.* 4, 5, 6, 7, 8, 9, 10 *and* 11.

HEMIPRONITES CRASSUS, *M. and H.* 1864. Paleont. Upper Missouri, p. 26, pl. I, fig 7.
HEMIPRONITES CRASSUS, *Meek*, 1872. U. S. Geol. Sur. Nebraska, p. 174, pl. V, fig. 10, and pl. VIII, fig. 1.

Shell subquadrate or transversely suboblong in marginal outline, compressed; hinge line usually a little shorter than the greatest transverse diameter of the shell, but it is sometimes equal to it; front margin broadly rounded; lateral margins rounded to the front, but straightened posteriorly, forming a more or less distinct angle with the cardinal border;

surface marked by numerous raised radiating striæ, which increase by implantation; the radiating striæ are crossed by numerous concentric lines and several stronger marks of growth; ventral valve nearly flat; cardinal border sloping a little to the lateral margins; beak more or less prominent, usually a little distorted; area flat, moderately broad, and inclined a little backward; pseudo-deltidium thick and moderately prominent; cardinal teeth small; scars of the adductor muscle large and separated by a thin mesial ridge, their outline well defined in old shells; dorsal valve gently convex in the middle and flattened at the postero-lateral portions; both valves marked by crenulations at the inner surface of the borders, but this feature is often obscured.

Length of an average sized example, as they are usually found in the Coal Measures, 25 mm.; breadth, 27 mm.

I have here given the name that this species has come to be generally known by, but it is now generally understood among paleontologists that it does not differ specifically from the *H. crenistria* of Phillips. It is also probable that King's generic name *Streptorhynchus* ought to be used for this group of shells, so that the species here described would then properly bear the name *Streptorhynchus crenistria.*

There is also a much larger form than the one here described, which occurs in the Coal Measure strata of Iowa and Missouri, but which seems to be in all other respects identical with this, although it becomes rough and ventricose with age. Professor Hall has described this form, in his Geology of Iowa, under the name of *Orthis robusta.* A form closely similar, and perhaps identical with the smaller form here described, has been found in the Lower Carboniferous rocks of Iowa.

Locality. This species may be sought for at the following Indiana localities: Lodi, Eugene, Perrysville, Merom, Big Creek, and New Harmony.

Genus MEEKELLA, *White and St. John.*

MEEKELLA STRIATOCOSTATA, *Cox.*

Plate 26, *figs.* 12, 13 *and* 14.

PLICATULA STRIATOCOSTATA, *Cox*, 1857. Geol. Sur. Kentucky, vol. III, p. 568, pl. VIII, fig. 7.
MEEKELLA STRIATOCOSTATA, *W. and St. J.*, 1867. Trans. Chi. Acad. Sci., I; p. 120.

Shell variable in size and shape, indistinctly trihedral in outline, both valves becoming gibbous at full adult age; hinge line usually much shorter than the greatest breadth of the shell; ventral valve usually more capacious than the other, but sometimes the difference in this respect is slight, deepest near the umbo; beak more or less distorted by being flattened, bent backward or to one side or the other, usually toward the dextral side; area triangular, more or less irregular in consequence of the distortion of the beak; height of the area seldom so great as its width at

the base, and often much less, its lateral borders well defined, its surface finely striated, both vertically and transversely; fissure varying in proportional width in different individuals, but usually quite narrow, and completely closed by a pseudo-deltidium, which is more or less flattened along each side, prominent along the middle, along which prominence there is a slightly raised mesial line; dorsal valve capacious, more regularly convex than the other; the convexity in some cases is so great behind the middle as to carry a portion of the valve a little behind the cardinal border; flattened along the middle toward the front, but never possessing a true mesial sinus; beak broadly convex, strongly incurved, not projecting over the hinge line; area obsolete, postero-lateral portions compressed so that small, thin ears are formed at the hinge extremities; surface of each valve marked by from ten to fourteen more or less angular radiating plications, having deep, angular interspaces between them; the plications not extending to the beak, increasing in size toward the front, mostly simple, but sometimes bifurcating; plications and interspaces both marked by numerous fine, radiating striæ which, toward the front margin of adult shells, usually converge to the crests of the plications, upon which they meet at acute angles; crossing these converging lines there are also usually zigzag lines of growth to be seen. The convergence of the radiating striæ does not take place until the shell has reached nearly mature size, and occasionally not then.

This shell is quite variable in size and shape, but it is thought that the foregoing description, together with the figures in plate 26, will enable any one to identify the species without difficulty. It is widely distributed in the Coal Measure strata of the States which border upon the Mississippi and Missouri Rivers, and it is also frequently found in the Rocky Mountain region.

Locality. The following Indiana localities have furnished examples of this species: Western part of Vigo county, and adjoining parts of Illinois.

Genus SYNTRIELASMA, *Meek and Worthen.*

SYNTRIELASMA HEMIPLICATA, *Hall.*

Plate 26, *figs.* 15, 16, 17 *and* 18.

SPIRIFER HEMIPLICATUS, *Hall*, 1852. Stansbury's Salt Lake Report, p. 409, pl. IV, fig. 3.
SYNTRIELASMA HEMIPLICATA, *M. and W.*, 1866. Illinois Geol. Sur., II, pp. 323 and 324.

Shell subglobose when fully adult, but only moderately convex when young; hinge line very short, not more than one-third the greatest transverse diameter of the shell; dorsal valve more convex than the ventral, strongly arched, especially in old shells; umbonal region gibbous, projecting backward a little beyond the cardinal border; area narrow, concave; ventral valve convex; beak slightly prominent and slightly incurved; area triangular, small, moderately well defined, higher than wide; surface

of both valves marked by fine, regular, crowded, radiating striæ, and a few large subangular radiating plications, which are most distinct at the front margin, but never reach the umbones; a few concentric lines of growth near the front, impart a zigzag appearance as they cross the plications and interspaces.

Genus RHYNCHONELLA, *Fischer.*

RHYNCHONELLA UTA, *Marcou.*

Plate 25, *fig.* 6.

RHYNCHONELLA OSAGENSIS, *Swallow*, 1858. Trans. St. Louis Acad. Sci., I, p. 219.
RHYNCHONELLA UTA, *Marcou*, 1858. Geol. of N. America, p. 51.

Shell rather small, varying considerably in form, usually subtrihedral in marginal outline, and somewhat wider than long; postero-lateral margins converging at an angle which varies in different shells from eighty to one hundred and ten degrees; front broadly rounded, emarginate at the middle; dorsal valve more capacious than the ventral, abruptly convex at the front; beak strongly incurved; mesial fold not prominent, and perceptible only at the front; plications somewhat angular, varying in number from seven to nine and rarely more, distinct at the front, but becoming obsolete at the middle and sides of the valve; from two to four of these plications are borne upon the mesial fold, which becomes obsolete backward with the plications; ventral valve rather shallow, similar to the other valve in the number, distribution, and character of the plications; beak narrow, prominent, and gently incurved; mesial sinus broad and shallow, having from one to three plications which are smaller than those at the sides, and, with the sinus, become obsolete about the middle of the valve; the posterior half of the shell plain, or marked only by occasional lines of growth.

The length of an adult example is about 10 mm.; breadth, 11 mm.

This shell has a very wide geographical range, it having been found from Indiana to Utah and New Mexico. It is closely related to a form that occurs in the Lower Carboniferous of Iowa, to which I gave the name of *R. Ottumwa*, and it is probable that the latter should be regarded only as a variety of the former.

Locality. This species has been found throughout Upper Coal Measures.

Genus SPIRIFER, *Sowerby.*

SPIRIFER CAMERATUS, *Morton.*

Plate 35, *figs.* 3, 4 *and* 5.

SPIRIFER CAMERATUS, *Morton*, 1836. American Journal of Science, XXIX, p. 150.
SPIRIFER CAMERATUS, *White*, 1881. Indiana Geol. Rep. for 1880, p. 149, pl. VIII, fig. 3.

This species was described in a former report (*loc. cit.*), but it is repeated

here with better illustrations, and for the purpose of bringing together all the Coal Measure species hitherto described for the Indiana Reports.

Shell usually of medium size, but sometimes quite large, subsemi-circular or subtrihedral in outline, almost always broadest at the hinge line; the hinge extremities often pointed and sometimes mucronate; dorsal valve not quite so capacious as the other; mesial fold distinct, broad at the front, sometimes sharply elevated, but more commonly rounded, clearly defined from front to beak and rapidly increasing in width to the front by the greater or less curving outward of the sides; sides of the valve sloping almost directly from the mesial fold to the lateral borders; antero-posterior convexity of the mesial fold very slight from front to middle, but increasing from the middle to the beak; beak small, projecting slightly over the cardinal border; ventral valve strongly arching from beak to front, the beak being prominent, pointed and curved over the area; area concave, of moderate width, and not narrowing to a sharp angle at the hinge extremities; foramen almost equilaterally triangular, partially closed by a pseudo-deltidium, which is often removed by weathering; mesial sinus well defined from front to beak and in all respects answering to the mesial fold of the other valve; surface marked by numerous distinct, rounded striæ of unequal size, which increase gradually in size toward the front; striæ increasing in number by the division near the beak of the few which are continuous to its point; they are thus generally gathered into more or less distinct fascicles of three or more striæ in each fascicle, the middle striæ of each fascicle being more prominent than the others, and these are the only striæ which reach the point of the beak; the mesial fold and sinus usually have striæ of the same character and arrangement as those upon other parts of the shell, but in some cases they are obsolete upon the sides of the fold and sinus respectively; besides the radiating striæ, the surface is marked by the usual lines and laminations of growth. This is one of the most common species in the Coal Measure strata of North America, of which it is also one of the most characteristic fossils.

Locality. Throughout the Coal Measures of Indiana.

Spirifer (Martinia) lineatus, *Martin.*

Plate 27, figs. 4, 5 and 6.

This species was described and figured in the Indiana Geological Report for 1881, page 372, and plate 42, figures 4, 5 and 6. These are repeated in this report for the purpose of bringing the Coal Measure fossils together.

The shell which is here figured is one which has usually been referred to *Spirifer lineatus*, Martin, but which McChesney described under the name of *S. perplexa*. Although it very closely resembles *S. lineatus*, one can hardly be satisfied that it is really specifically identical, and it is probable that we shall be justified in adopting McChesney's name. Not

having the means for direct comparison with the European form at hand, however, I prefer to leave our shell for the present with *S. lineatus*, where it has been placed by the majority of paleontologists who have noticed it, making the following brief description:

Shell moderately gibbous, transversely subelliptical in marginal outline, the front and sides regularly rounded; hinge much shorter than the width of the shell; cardinal extremities rounded; cardinal area distinct, arched and moderately high; ventral valve convex; umbonal portion prominent; beak prominent, incurved; area small; without median sinus, but there is a slight flattening of the valve at the front, which gives the front margin a very slight sinuosity; dorsal valve regularly convex, both transversely and longitudinally; umbonal portion prominent, but not so much so as that of the other valve; beak moderately prominent and projecting a little beyond the hinge line; surface marked by numerous very faint radiating lines and somewhat stronger concentric lines, the latter being impressed and finely crenulate, the minute crenulations apparently marking the bases of hair-like spines when the surface of the shell was perfect.

Length from ventral beak to front, 17 mm.; breadth, 18 mm.; greatest thickness, both valves together, 13 mm.

Locality. Fountain, Parke, Vermillion, Vigo, Sullivan, Gibson, Pike, Knox, Posey, Vanderburg and Warrick counties, Indiana.

SPIRIFER (MARTINIA) PLANOCONVEXA, *Shumard.*

Plate 32, *figs.* 23 *and* 24.

SPIRIFER PLANOCONVEXA, *Shumard*, 1855. Swallow's Geol. Report Missouri, p. 202.

Shell very small; breadth varying from a little more to a little less than the length; hinge line moderately long, but always shorter than the full breadth of the shell in front of it; lateral and front margins regularly and continuously rounded; the dorsal valve nearly flat, and it would be almost circular in marginal outline but for its truncation by the straight hinge line; beak minute, not prominent; cardinal area very narrow; ventral valve capacious, especially its posterior portion, which extends much behind the hinge line and ends in a prominent, strongly incurving, pointed beak; area very narrow, high, concave; mesial sinus absent, but in its place there is usually a slight flattening at the front, and sometimes an indistinct impressed line is seen to extend from the beak to the front margin; surface apparently smooth, but under a lens it is seen to be finely granular, the apparent granules being the bases of minute setæ; a few concentric lines of growth are usually observable upon both valves.

Length, 13 mm.; breadth, 13 mm.; convexity, 8 mm.

This common American shell agrees so closely in many respects with *S. Urii*, Fleming, from the British Carboniferous strata, that the propriety of placing it under any other specific name may well be questioned. In

view, however, of the fact that the characteristics of the subgenus *Martinia* admit of the development of very few salient specific features, I am at present disposed to regard these minor differences as affording sufficient reason for continuing the use of Shumard's name.

Locality. This little shell is one of the most widely distributed of the Coal Measure species. It has been found from Virginia to Utah and New Mexico, and in some of the strata of the States bordering upon the Mississippi and Missouri Rivers it occurs in great numbers. It has been found throughout the Coal Measures of Indiana.

Genus SPIRIFERINA, *d'Orbigny.*

SPIRIFERINA KENTUCKENSIS, *Shumard.*

Plate 35, *figs.* 13 *and* 14.

SPIRIFER KENTUCKENSIS, *Shumard*, 1855. Swallow's Geol. Sur. Missouri, p. 203.
SPIRIFERINA KENTUCKENSIS, *Meek*, 1872. U. S. Geol. Sur. Nebraska, p. 185.

Shell small, variable in outline, sometimes subsemicircular and occasionally almost globose, and sometimes the extremities are produced and mucronate; ventral valve more capacious than the dorsal; beak prominent, arching backward; area moderately high, well defined, concave; foramen higher than wide; mesial sinus distinctly defined, rather narrow, often moderately deep, without plications except occasionally a small obscure one at the bottom; dorsal valve somewhat regularly convex; beak scarcely prominent, projecting slightly over the cardinal margin; mesial fold narrow, distinctly defined, a faint linear depression sometimes observable along its middle, which corresponds with the small linear plication which is sometimes seen at the bottom of the sinus of the ventral valve; surface of each valve marked by from ten to eighteen simple prominent plications, rounded or almost angular at top and separated by interspaces of similar width; the plications which bound the sinus are a little larger and more prominent than the others, which thus serve to more clearly define the sinus from the remainder of the shell; the entire surface is also marked by fine, distinct, prominent and closely crowded lines of growth.

The length of a specimen of about average size and proportions is 9 mm.; breadth, between the hinge extremities, 13 mm.

Locality. This is one of the more common of the Coal Measure shells, but it is never found abundantly. It has been discovered at the following Indiana localities: In the Middle and Upper Coal Measures of Vermillion, Vigo, Knox, Gibson, Posey, Vanderburg, Dubois, and Spencer counties.

Genus ATHYRIS, *McCoy.*

ATHYRIS SUBTILITA, *Hall.*

Plate 35, *figs.* 6, 7, 8 *and* 9.

Among the fossil shells of North America, perhaps no species has come to be so well and widely known as this. It is also one of the most common and characteristic of the Coal Measure species.

It is variable in size, and somewhat also in outline, but it is seldom large; subovate in marginal outline, not often as wide as it is long, moderately gibbous, and old shells are sometimes inflated; ventral valve generally a little more capacious than the dorsal; beak prominent, strongly incurved; mesial sinus not very deep, even at the front, and becoming obsolete about the middle of the shell; a more or less distinctly impressed line usually exists along the bottom of the sinus, and extends from the beak to the front margin; dorsal valve somewhat uniformly convex, but more convex near the umbo than elsewhere; beak small, slightly prominent; mesial fold not distinctly defined; surface marked by concentric striæ and by occasional imbricating lines of growth; faint traces of radiating lines, such as are common on shells of this genus, are also occasionally seen.

Length of a specimen of ordinary size, 24 mm.; breadth, 20 mm.; height, 9 mm.

In all the variations which this shell is subject to, it is easily recognizable after an acquaintance with the species has once been formed. One of the most noticeable of its constant characteristics is the impressed mesial line at the bottom of the sinus of the ventral valve. This feature is sometimes obscure, but it is usually sufficiently distinct to be readily recognized. This species ranges through the whole Coal Measure series, and, according to Mr. Meek, into the Permian, also. In geographical distribution it is known from Virginia to the Rocky Mountain region.

Locality. It has been found common throughout the middle and Upper Coal Measures, rarer in Lower.

Genus RETZIA, *King.*

RETZIA MORMONII, *Marcou.*

Plate 35, *figs.* 10, 11 *and* 12.

TEREBRATULA MORMONII, *Marcou*, 1858. Geology of N. America, p. 51.
RETZIA PUNCTILIFERA, *Shumard*, 1858. Trans. St. Louis Acad. Sci., I, p. 220.

Shell small, ovate in outline; both valves more or less gibbous; hinge line short; ears minute and observable only in well preserved examples; ventral valve a little more capacious than the dorsal, posterior portion narrowed to the umbo, which is prominent and considerably arched; beak

small, truncated by a foramen of moderate size; area small but well defined; dorsal valve almost as prominently convex as the ventral; umbo prominent; beak incurved and extending a trifle over the cardinal border; surface of each valve marked by from fourteen to seventeen simple, narrow, radiating costæ, having interspaces of similar width; costæ sharply elevated, their backs, as well as the bottom of the interspaces, narrowly flattened; mesial fold and sinus wanting or obsolete.

Length of the largest examples, 12 mm.; breadth, 9 mm.; thickness, 8 mm.; but the average size is less.

This is another widely distributed Coal Measure species, and one that may be readily identified.

Genus TEREBRATULA, *Llhwyd.*

TEREBRATULA BOVIDENS, *Morton.*

Plate 32, *figs.* 17, 18 *and* 19.

TEREBRATULA BOVIDENS, *Morton*, 1836. Am. Jour. Sci., XXIX, p. 150.

Shell ovate or elongate-ovate in marginal outline; sides, behind the middle, laterally compressed, where also the shell is narrower and its vertical diameter greater than it is forward of the middle; ventral valve strongly arcuate from beak to front, the curvature being greatest behind the middle, rather more capacious than the other valve; beak prominent, incurved, but not coming quite in contact with that of the dorsal valve; foramen moderately large, not squarely truncating the beak, but opening obliquely backward; mesial sinus broad, more or less distinct at the anterior part of the valve, but becoming obsolete at or a little behind the middle; dental plates extending but little, if any, in front of the teeth, placed so near the sides of the beak that the space between them and the sides of the shell is very narrow; dorsal valve generally almost straight along the median line from the front margin to a little behind the middle, from which part it gently curves to the beak; gently and somewhat uniformly convex from side to side, without a mesial fold, except that sometimes the front margin is slightly raised to conform to the shallow sinus of the other valve; character of the loop not fully known, but it reaches farther forward than the middle of the shell; surface nearly smooth; shell structure finely punctate.

This shell varies considerably in size and shape. One example in the collection of the U. S. National Museum measures 30 mm. in length. An average size is about 17 mm. long and 12 or 13 mm. broad. This species is more or less common in Coal Measure strata, and it is known to range from Ohio to Nevada.

Locality. It has been found at the following localities in Indiana: Perrysville, Eugene, Newport, Lodi, Terre Haute (west of), Posey, Warrick, Perry and Crawford counties.

POLYZOA.

Genus SYNOCLADIA, *King.*

SYNOCLADIA BISERIALIS, *Swallow.*

Plate 25, *figs.* 11, 12 *and* 13.

SYNOCLADIA BISERIALIS, *Swallow*, 1858. Trans. St. Louis Acad. Sci., I, p. 179.

Polyzoary probably infundibuliform, but the specimens usually found consist only of spreading frond-like fragments; primary branches a little larger than the others, the latter increasing by divergence at various angles from the primary branches, also occasionally from each other, and rarely by starting upward from the middle of a dissepiment; dissepiments celluliferous, a little narrower than the branches, arching upward a little as they extend from branch to branch; fenestrules irregularly four-sided; upper side usually convex and the lower side sometimes concave; about nine of them may be measured in the length of a centimeter; measured upward, they are generally wider than the branches, but occasionally narrower, especially near the base of the polyzoary. Upon the poriferous side of the polyzoary the branches and dissepiments, especially the former, are each provided with an irregular mesial carina, consisting of small, elongate, confluent nodes, which are sometimes sharp and prominent. Cell-apertures moderately large, rounded, borders prominent; cells arranged in single, quite distinct lines, one on each side of the mesial carina of the branches, and generally each dissepiment bears a double row of similar cells. Upon some of the dissepiments the cells form only a single row at the middle, while upon others they are not only double, but another cell is added near the junction with the branch, giving three cells abreast at those points.

This form is one of the most common of the Fenestelloid Polyzoa that occur in Coal Measure strata.

Locality. It may be sought for in Indiana above the roof of coal K., and thence throughout Upper Coal Measures.

CONCHIFERA.

Genus LIMA, *Bruguiere.*

LIMA RETIFERA, *Shumard.*

Plate 28, *fig.* 4.

LIMA RETIFERA, *Shumard*, 1858. Trans. St. Louis Acad. Sci., I, p. 214.

Shell obliquely subovate; posterior side short; anterior side obliquely extended; the valves gently convex; cardinal border comparatively short; the basal border forming a nearly regular semi-circular curve; posterior margin regularly rounded; anterior margin somewhat narrowly

rounded below and sloping obliquely upward and backward to the cardinal border; ears small, distinct, nearly equal in size, the anterior one forming an obtuse angle and the posterior one a nearly right angle; beaks moderately prominent and projecting slightly beyond the cardinal margin, and situated near the mid-length of that margin; surface of each valve marked by about twenty-five angular radiating costæ, with interspaces of similar width with the costæ, all of which are crossed by numerous concentric, fine lamellations of growth.

Height, 15 mm.; length, 18 mm.

This is a somewhat rare shell, but it has a rather wide geographical range.

Locality. It may be sought for in the following Indiana localities: Knox, Gibson and Posey counties.

Genus MONOPTERIA, *Meek and Worthen.*

MONOPTERIA GIBBOSA, *Meek and Worthen.*

Plate 30, *figs.* 11 *and* 12.

MONOPTERIA GIBBOSA, *M. and W.*, 1866. Illinois Geol. Reports, II, p. 340, pl. 27, fig. 11.

Shell, exclusive of the wing and posterior prominence, irregularly suborbicular in marginal outline; the valves moderately convex or a little gibbous; the anterior and basal margins forming an almost regular semicircular curve; posterior portion of the shell produced, narrow and narrowly rounded, or subangular, at the extremity; wing slender, compressed and extending backward as far as the narrow posterior extremity, between which the posterior margin forms a deep, broad notch, that is narrowly rounded at the bottom; umbonal ridge moderately distinct; beaks equal, not placed so far forward as the front margin of the shell; anterior lunule deep; cardinal border not as long as the full diameter of the shell; surface marked only by the ordinary lines of growth.

Length, from posterior extremity to front, 27 mm.; height, from base to beaks, 23 mm.

Locality. This shell was originally described from Gallatin county, Illinois. It may be sought for in the following Indiana localities: Vermillion, Sullivan and Posey counties.

Genus MYALINA, *de Koninck.*

MYALINA SUBQUADRATA, *Shumard.*

Plate 29, *figs.* 1 *and* 2; *and plate* 30, *figs.* 1 *and* 2.

MYALINA SUBQUADRATA, *Shumard*, 1855. Swallow's Geol. Sur. Missouri, p. 207, pl. C, fig. 17.

Shell large, oblong in marginal outline, the height being much greater than the antero-posterior diameter; right valve nearly flat or only slightly convex; the left valve more convex than the right; hinge line nearly straight, usually equal to the greatest width of the valves, at right angles with the vertical axis of the shell; basal margin regularly, and sometimes, but not usually, somewhat narrowly rounded; posterior margin nearly vertical or moderately convex, rounding to the base below and usually meeting the hinge line at nearly right angles, but sometimes at an obtuse angle; anterior margin rounded to the basal margin, vertical along the middle, then reaching the projecting beaks by a moderately broad, concave curve; cardinal area moderately broad, the narrow cardinal furrows well defined; beaks terminal and projecting prominently forward; surface marked only by concentric lines and a few laminations of growth, which are more distinct upon the left valve than upon the right.

Height, from base to cardinal margin of a full grown example, 94 mm.; transverse width of the same, 58 mm.

Locality. This large *Myalina* has quite a large distribution in the Coal Measures. It has been found at the following Indiana localities: Upper Coal Measures of Knox, Gibson and Posey counties.

MYALINA RECURVIROSTRIS, *Meek and Worthen.*

Plate 29, *figs.* 3 *and* 4.

MYALINA RECURVIROSTRIS, *M. & W.*, 1866. Illinois Geol. Reports, II, p. 344, pl. XXVI, fig. 9.

Shell moderately large, except as compared with *M. subquadrata*; obliquely subtrigonal in marginal outline; posterior side compressed; transversely flattened a little beneath the beaks; both valves moderately convex, the left valve being more so than the other; umbo of each valve gibbous and narrowly rounded along the axis; cardinal border straight or slightly convex; its length about equal to the height of the shell in young examples, but it is proportionally shorter in adult examples; posterior margin gently convex in outline, its general range being at nearly right angles with the cardinal border, rounding gradually to the narrowly rounded basal margin; anterior margin rounding to the base below, a little concave above, where it ranges at an angle of about 55° with the cardinal border; beaks terminal, pointed; that of the left valve twisted so as to have a partially backward direction, but the other is merely directed forward; surface of both valves marked by numerous concentric

lamellæ of growth, which are most distinct upon the left valve, and more prominent upon the anterior part of the shell than elsewhere; ligament area narrow and traversed by a few longitudinal coarse striæ; just beneath the beaks the anterior margin is thickened so as to present a kind of false area, a little broader than the cardinal area; between these two areas, in the left valve, there is an oblique groove and a corresponding prominence in the right valve; posterior muscular impression large and elongate-subovate, the narrower end being uppermost and located near the middle of the posterior side.

Height, on a vertical line, at right angles with the hinge, 45 mm.; greatest breadth, 40 mm.; convexity, 24 mm.

Locality. The original examples of this species were obtained from the Upper Coal Measures, near La Salle, Illinois, but they may be sought for anywhere in the Indiana Upper Coal Measures.

MYALINA (?) SWALLOVI, *McChesney.*

Plate 30, *figs.* 6, 7 *and* 8.

MYALINA SWALLOVI, *McC.*, 1860. New Paleozoic Fossils, p. 57.

Shell small, oblique, equivalve or nearly so; valves gibbous along their upper median portion, the general aspect of the shell being like that of a *Modiola;* anterior margin sinuous, so that an indistinct small lobe is formed in front of the beaks and the somewhat prominent umbonal ridge; hinge line equal to about one-half the entire length of the valves, straight, meeting the posterior margin without a perceptible angle; postero-basal margin narrowly rounded; cardinal area very narrow and marked by two or three indistinct longitudinal striæ; surface marked by the ordinary concentric lines and a few imbrications of growth.

Extreme length of an average sized example, 28 mm.; greatest transverse breadth, 14 mm.; convexity, 10 mm.

This is a shell concerning which the real generic relations have been regarded as obscure by every author who has written of it. It seems to be worthy of at least a separate subgeneric designation, but none has hitherto been proposed for it.

Locality. It has a very wide distribution in the North American Carboniferous rocks, and in the States bordering the Mississippi it is regarded as characteristic of the Upper Coal Measures. It has been found at the following Indiana localities: Parke, Vermillion and Vigo counties, at the horizon of coal M.

Genus ENTOLIUM, *Meek.*

ENTOLIUM AVICULATUM, *Swallow.*

Plate 28, *figs.* 7 *and* 8.

PECTEN AVICULATUS, *Swallow*, 1858. Trans. Acad. Sci. St. Louis, I, p. 215.
ENTOLIUM AVICULATUM, *Meek*, 1872. U. S. Geol. Sur. Nebraska, p. 189, pl. IX, fig. 11.

Shell compressed lenticular, thin, equivalve, suborbicular in marginal outline, exclusive of the ears; height usually a trifle greater than the transverse width of the shell; the lateral margins, from the mid-height of the shell, regularly and continuously rounded with the basal margin; lateral margins above the mid-height, straight and converging toward the beaks; cardinal margin short, its length less than one-third the transverse diameter of the shell; ears small, flat and nearly equal, obtusely angular at the extremities, defined from the body of the valves by a distinct depression, but not by any auricular grooves; beaks small, compressed, equal, not projecting beyond the cardinal margin; each valve has two shallow, undefined impressions diverging from the beak nearly to the anterior and posterior margins respectively, that on the posterior side being the longer; surface apparently plain, but under a magnifier it is seen to be marked by very fine, close-set, concentric striæ, and occasionally traces of fine radiating striæ.

Height, 24 mm.; breadth, 22 mm.

Locality. This species is found in both the Upper and Lower Coal Measures. Its known geographical range is from Indiana to Nebraska. It has been found at the following Indiana localities: Horizons of coals K., L. and M., in Fountain, Vermillion, Vigo, Pike, Dubois, Perry, and Spencer counties.

Genus EUMICROTIS, *Meek.*

EUMICROTIS HAWNI, *Meek and Hayden.*

Plate 30, *fig.* 10.

EUMICROTIS HAWNI, *M. and W.*, 1866. Illinois Geol. Reports, II, p. 338, pl. 27, figs. 12, 13, and 14.

Shell subovoid in marginal outline; obliquity, little or none; upper posterior margin nearly straight, sloping abruptly downward from the cardinal margin; anterior margin more or less regularly rounded below the ear; basal margin somewhat regularly rounded; cardinal not so long as the median transverse diameter of the shell; hinge area moderately broad; cartilage pit distinct, placed immediately below the beak in each valve; left valve moderately ventricose; umbo a little incurved and projecting a little above the cardinal margin; posterior ear narrow, obliquely truncated; anterior ear larger, its outer margin narrowly rounded; the

notch below it deep and subangular; surface marked by somewhat irregular undulating costæ of unequal size; these are crossed by more or less distinct lamellæ of growth, which are sometimes vaulted on the costæ; right valve nearly flat; byssal sinus deep and narrow; surface more obscurely marked than that of the left valve.

Height, 34 mm.; breadth, 28 mm.

Locality. The original specimens were obtained in Kansas. It is also known in Illinois, and may be sought for in the Upper Coal Measures of Indiana.

Genus AVICULOPECTEN, *McCoy.*

AVICULOPECTEN OCCIDENTALIS, *Shumard.*

Plate 28, *fig.* 3.

PECTEN OCCIDENTALIS, *Shumard*, 1855. Swallow's Geol. Report Missouri, p. 207, pl. C, fig. 18.

Shell inequivalve; both ears well defined; cardinal border at nearly right angles with the axis of the shell and almost as long as its full antero-posterior diameter; marginal outline, exclusive of the ears, subovate; left valve more convex than the right; anterior ear about as long as the posterior one, more convex and a little more sharply defined, by the auricular furrow, from the body of the valve than the other ear, its extremity obtuse, and inferior border concave; its surface marked by distinct radiating costæ, which are a little coarser than those upon the body of the valve at the same distance from the beak; posterior ear clearly defined from the body of the valve by a shallow auricular furrow, sharply angular at the outer extremity; outer margin concave, its surface marked by concentric lines, all radiate markings being obsolete; surface of the body of the valve marked by depressed, flattened, or very slightly convex, radiating costæ, which gradually increase in size toward the free margins, and increase in number by implantation at different distances from the beak, only about a dozen of them reaching it; the implanted costæ, beginning as mere striæ between the others, are of unequal size on all parts of the valve; the costæ are crossed by numerous distinct concentric striæ; right valve flat or slightly convex; beak flattened, and not distinct, as such, at the cardinal border; costæ similar in character to those of the other valve, but they are not nearly so distinct; outline corresponding with that of the left valve, except that the anterior ear is narrower, and defined by a deeper and sharply angular sinus.

Height, from base to cardinal border, 42 mm.; breadth, 37 mm.

This is one of the most common Conchifers of the Carboniferous rocks of the United States, from Indiana westward, and it has been found in Utah and Arizona. It ranges, also, from the Lower Coal Measures to the Upper, and, according to Meek, it passes up into the Permian strata in Kansas.

Locality. It has been found in Pike and Gibson counties, Indiana.

AVICULOPECTEN CARBONIFERUS, *Stevens*.

Plate 28, *figs.* 5 *and* 6.

PECTEN CARBONIFEROUS, *Stevens*, 1858. Am. Jour. Sci., XXV, p. 261.

Shell rather less than medium size; its axis a little oblique with the cardinal border; moderately convex; the height and breadth nearly equal; cardinal border nearly or quite straight; its length not quite equal to the transverse diameter of the shell, bearing a marginal ridge in each valve; full margin, regularly and continuously rounded from a little below the mid-height of the shell on the posterior side to a little above it on the anterior side; above this rounded portion the sides of the body of the shell, exclusive of the ears, slope directly to the beak; left valve more convex than the other; the posterior ear well defined, somewhat extended and acutely pointed at the extremity, its outer and lower margin broadly concave; anterior ear about two-thirds as long as the other, more obtuse at the extremity but still angular, distinctly defined from the body of the valve by an auricular furrow, and divided below by a subangular sinus; right valve nearly flat or very gently convex, its anterior ear narrow, and beneath it there is a deep abrupt sinus; posterior ear similar in size and shape with that of the left valve; the left valve bears fifteen or sixteen angular radiating ribs which are separated by furrows of similar size with the ribs, each one terminating at the free border in a sharp, recurved spine; the surface is also marked by lines of growth, which are more distinctly observable upon the ears, which are not marked by distinct radiating features; besides the lines of growth, there are, at somewhat regular intervals, distinct concentric imbrications, which, having been once free borders, show digitations similar to those of the margin; the surface markings of the right valve are similar to those of the left, but much less distinct.

Height, from base to cardinal margin, 19 mm.; breadth about the same.

This is probably the same species that was described, but not figured, by Professor Swallow, from the Upper Coal Measures of Missouri, under the name of *Pecten Broadheadi*; and it is no doubt identical with the *Pecten Hawni* of Geinitz, from Nebraska. Specimens of the same have also been found in New Mexico, by parties connected with the United States explorations and surveys west of the 100th meridian.

Locality. This species has been found at the following localities in Indiana: At Lick Branch, near Silverwood, Fountain county, and in Vermillion county.

AVICULOPECTEN (?) INTERLINEATUS, *Meek and Worthen.*

Plate 30, *fig.* 9.

AVICULOPECTEN INTERLINEATUS, *M. and W.* Illinois Geol. Sur. II, p. 329, pl. 26, fig. 7.

Shell rather small, broadly subovate in outline exclusive of the ears; breadth nearly equal to the height, slightly oblique, or the axis almost at right angles with the cardinal border; hinge line about equal in length to the full breadth of the shell; ears prominent, posterior one more prominent than the other; anterior, basal, and posterior margins regularly and continuously rounded; beak depressed; umbonal slopes moderately distinct; left valve slightly convex or nearly flat; posterior ear a little larger, or nearly of the same size as the other, produced to a sharp angle at the cardinal extremity, its outer border sometimes straight and sometimes curved, and forming an obtuse retreating angle with the posterior margin of the shell; anterior ear triangular, flattened, its outer border slightly convex or nearly straight, and its extremity bluntly angular; surface marked by ten or twelve sharply raised, slender, concentric ridges, each one being of nearly uniform width throughout, but each successively a trifle stronger than the preceding one, separated, along the axis of the valve, by interspaces each of which are four or five times as wide as the adjacent concentric ridges; but the interspaces diminish in width toward the umbonal region, upon which the ridges are very near together; the latter then diverge, crossing the ears, and all end abruptly upon the cardinal margin; surface between the ridges marked by numerous fine, uniform, concentric striæ, and also by faint indications of radiating costæ.

Breadth, 17 mm.; height, from base to cardinal margin, 16 mm.

This interesting shell is somewhat rare, but it is known in the widely distant regions of Central Illinois and Northern Arizona.

Locality. It may be reasonably sought for in the Upper Coal Measures of Indiana.

Genus PINNA, *Linnæus.*

PINNA PERACUTA, *Shumard.*

Plate 28, *figs.* 1 *and* 2.

PINNA PERACUTA, *Shumard*, 1858. Trans. St. Louis Acad. Sci., I, p. 214.

Shell long and slender, tapering regularly from the larger to the smaller extremity; the valves so convex that the shell is subcylindrical, except toward the larger end where it is more flattened; hinge margin straight; the dorsal edges of the valves suddenly erected so as to give the hinge margin a carinated appearance; ventral margin straight like the dorsal, with which it forms an angle of about 12°; posterior margin rounded broadly and obliquely upward and backward to the dorsal margin; surface plain, marked only by obscure concentric lines of growth.

This species is remarkable for its long and slender form. The full length of the largest examples could not have been less than 250 mm.

Locality. It is known in both the Upper and Lower Coal Measures, from Indiana to Nebraska. It has been found in the Upper, Middle and Lower Coal Measures of Indiana.

Genus NUCULANA, *Link.*

NUCULANA BELLISTRIATA, *Stevens.*

Plate 31, *figs.* 8 *and* 9.

LEDA BELLISTRIATA, *Stevens*, 1858. Amer. Jour. Sci., XXV, p. 261.

Shell transversely elongate-subovate, gibbous anteriorly and attenuate behind; basal margin broadly convex, straightened in the middle; anterior margin narrowly rounded; posterior margin very narrow; postero-dorsal margin nearly straight, sloping backward and a little downward from behind the beaks; umbonal ridges well defined, situated near to the postero-dorsal margin, their outline, as seen from above, forming an elongate ellipse which has a concave surface on each side of the median ridge, which is formed by the up-flexed margins of the valves there; umbones prominent; beaks incurved, situated about two-fifths of the full length of the shell from its front; surface marked by fine, regular, concentric, raised striæ, which are obsolete upon the umbonal ridges and the space which they enclose.

Length of a large example, 27 mm.; height, 12 mm.; convexity, 9 mm. A large majority of the examples are considerably smaller than this.

Locality. This species has been found at the following localities: Horizon of coal M., in Vermillion, Sullivan, Vanderburg, and Warrick counties.

Genus NUCULA, *Lamarck.*

NUCULA VENTRICOSA, *Hall.*

Plate 27, *figs.* 9 *and* 10.

NUCULA VENTRICOSA, *Hall*, 1858. Geol. of Iowa, Part II, p. 716, pl. 29, fig. 5.
NUCULA VENTRICOSA, *White*, 1882. Ind. Geol. Rep. for 1881, p. 371, pl. 42, figs. 9 and 10.

Shell small, subovate in marginal outline; valves ventricose, the greatest convexity being a little forward of the middle; posterior end short, obliquely truncated from the beaks to the narrowly rounded posterior margin; basal margin broadly rounded; front margin narrowly rounded; dorsal margin sloping downward with a gentle convex curve to the front margin; beaks well defined, incurved; a more or less distinct dorsal con-

cavity behind them; the general surface having a smooth appearance, but concentric striæ are generally observable toward the basal margin.

Locality. Coal Measure strata, Sullivan county, Indiana, and generally at roof of coal M.

Genus SCHIZODUS, *King.*

SCHIZODUS WHEELERI, *Swallow.*

Plate 30, *figs.* 3, 4 *and* 5.

CYPRICARDIA WHEELERI, *Swallow*, 1862. Trans. St. Louis Acad. Sci., II, p. 96.
SCHIZODUS WHEELERI, *Meek*, 1872. U. S. Geol. Sur. Nebraska, p. 209, pl. X, fig. 1.

Shell of moderate size, irregularly subtrihedral or subovate in marginal outline; posterior portion laterally compressed; anterior portion inflated; umbones elevated; beaks incurved, situated at about one-quarter of the full length of the shell from the anterior extremity; margins of the front and the anterior part of the base forming a continuous and regular curve; basal margin sloping upward and meeting the downward and backward slope of the posterior margin at a prominent angle, which is abruptly rounded at the extremity; dorsal margin straight, sloping a little downward from the beaks to the obliquely truncated posterior margin; posterior umbonal slope prominent, sometimes forming a rather distinct ridge, which ends at the prominent angle of the posterior margin and considerably increases its projection; surface marked only by the ordinary lines of growth.

Length of an ordinary sized example, from the front margin to the posterior angle, 31 mm.; height, from base to umbones, 22 mm.

This is a widely distributed Coal Measure species, it being known to range from Indiana to Nebraska and New Mexico. It is usually found in the condition of casts of the interior of the shell, which give no surface features, but in such cases it is recognizable with little difficulty by its shape.

Locality. It may be reasonably sought for in the Upper Coal Measures of Indiana.

Genus CLINOPISTHA, *Meek and Worthen.*

CLINOPISTHA RADIATA, *Hall.*

Plate 31, *figs.* 6 *and* 7.

EDMONDIA RADIATA, *Hall*, 1858. Geology of Iowa, part II, p. 716, pl. XXIX, fig 3.
CLINOPISTHA RADIATA, *M. & W.*, 1873. Illinois Geol. Reports, V, p. 584, pl. XXVII, fig. 7.

Shell irregularly oblong or suboval in marginal outline, the anterior side being somewhat deeper than the posterior; the valves moderately convex when young, but the shell becomes ventricose with age; beaks obtuse, moderately prominent, situated very near the posterior end of the

shell; anterior margin regularly rounded; posterior margin short, vertically truncated; basal margin straightened or slightly emarginate; dorsal margin nearly straight and rounded down to the front margin; ligament short, suboval, and situated immediately behind the beaks; surface having a polished aspect, but it shows fine concentric lines of growth and obscure, fine, radiating lines.

Length, 25 mm.; height, 16 mm.; convexity, 10 mm.

Locality. Upper Coal Measures of Indiana.

Genus EDMONDIA, *de Koninck.*

EDMONDIA ASPINWALLENSIS, *Meek.*

Plate 31, *figs.* 4 *and* 5.

EDMONDIA ASPINWALLENSIS, *Meek*, 1872. U. S. Geol. Survey Nebraska, p. 216, pl. IV, fig. 2.

Shell transversely subovate in marginal outline; valves having considerable convexity, the greatest being in front of, and a little above the middle; basal margin broadly convex; posterior margin somewhat narrowly rounded or sometimes faintly subtruncate; dorsal margin sloping a little downward with a slight convexity; anterior dorsal margin short, and declining abruptly to the narrowly rounded front margin; beaks not prominent, incurved, situated near the anterior end of the shell; surface marked by distinct lines and undulations of growth.

Length, 37 mm.; height, 27 mm.; diameter, 18 mm.

Locality. This species is known to range from West Virginia to Nebraska. It may be sought for in the Upper and Middle Coal Measures of Indiana.

Genus ALLORISMA, *King.*

ALLORISMA SUBCUNEATA, *Meek and Hayden.*

Plate 31, *figs.* 1, 2 *and* 3.

ALLORISMA SUBCUNEATA, *M. and H.*, 1861. Paleont. Upper Missouri, p. 37, pl. I, fig. 10.

Shell reaching a large size, transversely elongate, being two or more times as long as high, gibbous anteriorly, compressed posteriorly, where the valves are a little gaping; basal and dorsal margins sub-parallel, the latter very broadly convex; posterior margin narrowly rounded; front margin still more narrowly rounded below, but above it slopes abruptly upward and backward toward the beaks; dorsal margin slightly concave or nearly straight, and rounded to the posterior border; surface marked by concentric lines and distinct undulations of growth.

Length, 103 mm.; height, from base to cardinal margin, 41 mm. Many examples are somewhat smaller than this, but, occasionally, an example is found that is considerably larger.

This large fine shell has a very wide geographical range, it being known from Indiana to Utah and New Mexico. Throughout this wide range it retains all its essential characteristics so completely that it is readily recognizable.

Locality. It has been found throughout the Coal Measures of Indiana.

GASTEROPODA.

The genera Macrocheilus and Soleniscus.

No more confusion probably exists in relation to any group of fossil shells than is to be found among those which have been referred to the genus *Macrocheilus*, from North American Devonian and Carboniferous strata. Not only have shells of doubtful and diverse character been referred to that genus by different authors, but much uncertainty also exists as to the specific identity of the forms to which various specific names have been given. The causes of this uncertainty are various. First, several of the species which have been proposed have never been figured, the type specimens are inaccessible, and the descriptions alone are insufficient to permit a satisfactory discrimination of those species among the closely related forms. Second, the range of variation among all the recognizable species is so great that with numerous specimens in hand it is often difficult to decide upon definite specific limits. Third, dissimilar groups of species have been placed together under *Macrocheilus*.

Among the somewhat numerous North American Devonian and Carboniferous species, especially the latter, that have been referred to the genus *Macrocheilus* of Phillips, are certain forms which plainly do not answer the description of that genus as it was originally given, or as its characteristics have usually been stated by authors. The differences between these species and those which I regard as true *Macrocheilus* pertain mainly to the columella and inner lip; but they also possess a more massive test. Some of the American species which have been referred to *Macrocheilus* have a plain, more or less sinuous, inner lip, which is only slightly covered with callus and destitute of any trace of ridges or folds. These, I assume to be typical forms of that genus, and the following, among others, may be mentioned as examples: *Macrocheilus Hebe* and *M. Hamiltonæ*, Hall, of the Devonian; and *M. anguliferus*, White, of the Carboniferous. My present belief is that all the Devonian forms that have been referred to *Macrocheilus* will fall into this group, but that it will properly include only a very small part of those which have been referred to that genus from Carboniferous strata. With the very few

exceptions referred to, I think all the numerous North American Carboniferous forms which various authors have referred to *Macrocheilus* constitute a distinct natural group which ought to be designated by one, and a different, generic name. I, also, think the form for which Meek and Worthen proposed the generic name of *Soleniscus* ought to be included in this group.

The shells of the group in question are characterized by a more or less thickened inner lip, which also bears one more or less distinct revolving fold. This fold, when the outer lip is entire, is usually visible only as an obtuse prominence near the anterior end of the inner lip; but upon breaking away the outer lip the fold is usually found to be distinct, and often sharp and prominent. Sometimes, also, there is, upon the posterior side of the fold, a broad concave depression which ends at, and deepens, the inward flexure of the inner lip, the posterior border of which depression is sometimes so well defined as to appear like a second revolving fold. This depression is excavated out of the callus which covers the columella and inner lip quite thickly, in such cases, between the depression and the posterior angle of the aperture. Forward of the fold there is little, and sometimes no, accumulation of callus, the anterior end of the outer lip, where it joins the inner lip, being usually thin and more or less prominent when entire. There is, therefore, in unbroken shells, a rather broad, short, more or less distinct, anterior canal, too broad and short to really deserve the name of canal, strongly recalling the corresponding part of *Nassa*. The anterior border of this short canal, however, is prominent, and not emarginate as in *Nassa*.

From the fact that the columellar fold upon these Carboniferous shells is distinct only within the aperture, and that the latter is usually filled with the imbedding matrix, this distinguishing feature seems to have generally escaped the notice of authors. It has not always done so, however, both those eminent paleontologists, Professors Hall * and Geinitz,† having referred to it in published descriptions. Meek and Worthen also observed that the inner lip is "usually provided with an obtuse revolving fold," but none of these authors appear to have regarded that feature as separating such shells generically from those which are destitute of it. Mr. Conrad, however, so early as 1842, proposed the generic name of *Plectostylus* to include shells possessing this character; but that name was previously used by Beck for an entirely different group of mollusks. Mr. S. A. Miller, also, in his Catalogue of American Paleozoic Fossils, refers the *Macrocheilus Halli* of Geinitz to *Soleniscus*, Meek and Worthen. In 1881, I described ‡ two species of this group from the Carboniferous rocks of New Mexico, and also referred them to *Soleniscus*.

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* Geology of Iowa, 1858, Part II, pages 719 and 720.

† Carbonformation und Dyas, in Nebraska, 1866, page 6.

‡ Expl. and Sur. West of the 100th Merid. Supp. to vol. III, pp. 28 and 29, pl. IV, figs. 4 and 5.

Notwithstanding the conscientious accuracy which is apparent in all the work of those authors, I suspected that the anterior portion of their type species is not so prominent as it is represented to be by the restored part of their figures. Applying to Mr. Worthen for permission to examine the type specimen, I learned that it was inaccessible, but he sent me, for examination, an authentic duplicate example. A careful examination of this specimen satisfies me that the anterior portion of the shell in this species is really only a little more prominent than it is in several of those forms which have been referred to *Macrocheilus*, and that that portion is not produced into a proper beak. Meek and Worthen's figures show that the anterior portion of their type-specimen was broken off; and if the line of the restored part had been continued with the curve of the outer lip, or the longitudinal convexity of the volution, it would agree with the lines of growth which are observable upon the specimens sent me by Mr. Worthen. Moreover, their figure shows a prominence of the fold upon the inner lip which did not appear on the one just referred to, until I had dug deeply into the stony material which had filled the aperture. Their figure also appears to represent the outer lip as entire; but to exhibit the columellar fold so prominently as it appears in that figure, the outer lip must have been largely removed. So removing the outer lip, and not its anterior part, would leave the latter having somewhat the appearance of a beak.

Understanding the real characters of the type species of *Soleniscus* to be such as I have here indicated, it is, I think, necessary to regard the form to which they applied that name as congeneric with the greater part, if not all, the forms which are figured with it on plate 34, and with most of those Carboniferous shells which have been by different authors referred to *Macrocheilus*. According to my observations, the principal differences which that species presents from the others referred to, are its more than usually elongate form, a little greater than the usual prominence of the anterior part of the aperture, and a smaller accumulation of callus upon the inner lip.

These forms, as before remarked, are regarded as constituting a natural group which, it appears to me, well deserve a generic designation distinct from *Macrocheilus*. If it were not that Conrad's name *Plectostylus* was preoccupied by Beck, that name could be appropriately retained for this group, to which it was really applied. Conrad's name not being available, the next generic name that has been used for any member of the group ought to be used for the whole group. As *Soleniscus* is regarded as a member of this group, that name ought to be used for it, because no other available name has priority over it.

The following species, which have hitherto been referred to *Macrocheilus*, have been found to possess the prominent columellar fold and other characteristics of the group here discussed, and I would, therefore, refer them

all to *Soleniscus;* *Macrocheilus fusiformis*, Hall, *M. Newberryi*, Hall, *M. planus*, White, *M. ventricosus*, Hall, *Soleniscus brevis*, White, *M. Texanus*, Shumard?, *M. paludinæformis*, Hall, and *M. Halli*, Geinitz. All except the last are figured on plate 34.

It is not to be denied that there are certain forms among those Carboniferous species, which have usually been referred to *Macrocheilus*, that possess, at best, only an obtuse fold upon the columella. They are, however, much more closely related, by all their characteristics, to the species just referred to *Soleniscus*, than are those Devonian and other species which I have refered to *Macrocheilus* proper. Among these species are the three following, which are represented, with the others, on plate 34: *Macrocheilus ponderosus*, Swallow?, *M. medialis*, Meek and Worthen, and *M. primigenius*, Conrad. These, I regard as, at most, no more than subgenerically different from those which I have referred to *Soleniscus*.

Genus SOLENISCUS, *Meek and Worthen.*

SOLENISCUS TYPICUS, *Meek and Worthen.*

Plate 34, *figs.* 18 *and* 19.

SOLENISCUS TYPICUS, *M. and W.*, 1860. Ill. Geol. Rep., II, p. 384, pl. 31, figs. 15 a and 15 b.

Shell fusiform; spire produced, conical, acute at the apex; volutions, seven or more, gently convex, the last one constituting at least three-quarters of the full length of the shell, moderately ventricose about the middle and tapering a little toward the front; aperture comparatively narrow, acute posteriorly, narrowed at the front, outer lip thin and sharp; suture slightly impressed; fold of the columella nearer to the front end of the aperture than to the posterior end, inconspicuous when the outer lip is entire, but prominent within the aperture; surface plain, showing only the usual fine lines of growth.

Length, about 18 mm.; diameter of the last volution, 9 mm.; apical angle, the sides being slightly concave, about 40°.

This appears to be a rather rare species, and has hitherto been found only in the Upper Coal Measure rocks, in the vicinity of Springfield, Illinois; but it is likely to be found in the corresponding rocks in Indiana.

This species was made the type of the genus *Soleniscus*, by Meek and Worthen, but, as I have already shown, a large proportion of the shells that have been referred to the genus *Macrocheilus* possess essentially the same generic characters.

Soleniscus (Macrocheilus) Newberryi, *Stevens.*

Plate 34, *figs.* 7 *and* 8.

Loxonema Newberryi, *Stevens*, 1858. Am. Jour. Sci. (2) XXV, p. 259.
Macrocheilus Newberryi, *Hall*, 1858. Geology of Iowa, Part 2, pl. 719, p. XXIX, fig. 9.

Shell fusiform; spire produced; its sides convex, apex acute; volutions seven or more, the last one moderately ventricose and constituting more than half the full length of the shell; those of the spire moderately convex; suture distinct, but not very deeply impressed; aperture comparatively narrow; outer lip thin, but the remainder of the test comparatively thick; inner lip thickened by callus; collumella appearing flexuous, and with an obtuse fold anteriorly, when the outer lip is entire, but when the latter is much broken away that fold is found to be angular and prominent, with a deep, broad, concave groove behind it; the posterior side of that groove being abruptly rounded has much the appearance of a second revolving fold; in front of the fold, and between it and the front border of the aperture, there is a narrow concave space or a short broad canal; surface marked by the ordinary fine lines of growth, but it has, in well preserved examples, an almost polished aspect.

Length, 26 mm.; breadth of the last volution, 12 mm.

Locality. Danville, Illinois; but it may be looked for at the horizons of coals M. and N., in Indiana.

Soleniscus planus, *White.*

Plate 34, *figs.* 9 *and* 10.

Soleniscus planus, *White*, 1881. Expl. and Sur. west of the 100th Merid., Sup. to Vol. III, p. XXIX, pl. IV, fig. 4.

Shell subfusiform; spire nearly one-half the full length of the shell; its side gently convex; apex acute; volutions eight or more; those of the spire gently convex; the last one large, but not much ventricose; suture distinct but not deep; test moderately thick; fold of the columella well developed and placed a little forward of the mid-length of the aperture; the spiral groove behind it broad, concave, and well defined; the callus of the inner lip thick, especially behind the groove; outer lip thin, its margin sharp; surface marked only by the usual lines of growth.

Length, 27 mm.; greatest diameter, 9 mm.

This form was described by me from the Carboniferous rocks of New Mexico (*loc. cit.*). I am now inclined to regard it as identical with the *Macrocheilus Newberryi* of Hall, but still it presents such variations that, for the present, I retain it under the name I have applied. At the time I described it, I was not aware that the *M. Newberryi* possessed the distinct columellar fold that I have now shown it to possess, as well as *S.*

planus. Considering the evident wide specific variation of these forms, it seems not improbable that, with full collections in hand, it will be difficult to clearly define the specific boundaries between *S. Newberryi*, *S. planus*, and *S. fusiformis;* all three of which are here separately described.

Locality. The form figured on plate 34 was obtained from near Danville, Illinois; but it may be sought for in Indiana at the horizons of the roof of coals M. and N., and in the Upper Coal Measures.

SOLENISCUS (MACROCHEILUS) FUSIFORMIS, *Hall.*

Plate 34, *figs*, 4, 5 *and* 6.

MACROCHEILUS FUSIFORMIS, *Hall*, 1858. Geology of Iowa, part II, p. 718, pl. XXIX, fig. 7.

Shell elongate-subfusiform; spire more than half the full length of the shell; its sides nearly straight or slightly convex; volutions about ten in number, those of the spire gently convex, the last one large and moderately ventricose; suture shallow; test moderately thick, but the outer lip is thin and sharp when entire; inner lip covered with a strong callus; columellar fold distinct within the aperture, its outer portion obtuse; groove behind the fold broad and deeply concave, with its posterior margin obtuse, but distinctly defined; surface marked only by the ordinary lines of growth.

Length, about 40 mm.; diameter of the last volution, 15 mm.

The specimens here described differ somewhat from the description and figure given by Prof. Hall, but the differences are assumed to be of a varietal character only. As already remarked, however, this form is closely similar to the two forms herein just described.

Locality. Prof. Hall's type specimen is from the Coal Measures of Iowa. The forms here described are from Illinois. The species may be sought for in the Upper Coal Measures of Indiana.

SOLENISCUS (MACROCHEILUS) PALUDINÆFORMIS, *Hall.*

Plate 34, *fig.* 17.

MACROCHEILUS PALUDINÆFORMIS, *Hall*, 1858. Geol. Iowa, part II, p. 719, pl. XXIX, fig. 10.

Shell short subfusiform; spire prominent, but it constitutes somewhat less than half the full length of the shell; its sides gently concave; its apex small, acute; volutions eight or more in number, those of the spire gently convex, the last one ventricose; suture slightly impressed; test comparatively thin for a shell of this group, but there is a thick accumulation of callus upon the inner lip; columellar fold distinct; the groove behind it broad, concave and deep, as seen after a portion of the last volution is removed; surface marked by the ordinary lines of growth.

Length, about 26 mm.; diameter, 15 mm.

I have no doubt that the specimen upon which the foregoing description is based is specifically identical with the *Macrocheilus paludinæformis* of Hall. It is possible, also, as Prof. Hall remarks, that it was upon a cast of this species that Conrad proposed the genus *Plectostylus*, but his specimen being only a cast of the interior, its specific identity can not be fully known.

Locality. The specimen here described is from the Coal Measures of Vermillion county, Indiana. The species is also known to exist in the corresponding strata of Illinois and Iowa.

Soleniscus (Macrocheilus) ventricosus, *Hall.*

Plate 34, *figs.* 11 *and* 12.

Macrocheilus ventricosus, *Hall*, 1858. Geology of Iowa. part II, p. 718, pl. XXIX, fig. 8.
Soleniscus brevis, *White*, 1881. Expl. and Sur. West of 100th Merid., Supp. to Vol. III, p. 28, fig. 5.

Shell subglobose; spire very short, apex small and prominent; volutions about eight in number, those of the spire moderately convex, the last one ventricose; test moderately thick; suture distinct, but not deep; fold of the columella prominent, especially within the aperture, situated a little in advance of the mid-length of the aperture; a distinct, rather broad, deep concavity or revolving furrow at the distal side of the fold; callus of the inner lip moderately thick and broad; surface marked only by the usual lines of growth.

Length 17 mm.; diameter of the last volution, 11 mm.

This is a widely distributed species, and a somewhat variable one, especially in the prominence of the spire; but its small size and globose form render its identification an easy matter. I failed in identifying it with the New Mexican form (*loc. cit.*), because I did not then know that the authentic forms possessed the distinct columella fold that they are now known to have.

Locality. Specimens of this species have been found in Illinois, Iowa, and New Mexico. They may be sought for, in Indiana, at the horizon of coal M. and in the Upper Coal Measures.

Soleniscus (Macrocheilus) Texanus, *Shumard (?)*

Plate 34, *figs.* 13 *and* 14.

Macrocheilus Texanus, *Shumard*, 1859. Trans. St. Louis Acad. Sci., Vol. I, p. 402.

The form figured on plate 34, is doubtfully indentified with the *Macrocheilus Texanus* of Shumard. I am not satisfied that this is not a large variety of *S.* (*M.*) *ventricosus*, but for the present I prefer to regard it as distinct. It is somewhat more globose than *S.* (*M.*) *ventricosus*, and the spire is proportionally less prominent than it usually is in that species.

Shumard's type was found in Texas, and the specimen here figured was obtained from the Coal Measure strata at Danville, Illinois. It is likely to be found in the Upper Coal Measures of Indiana.

SOLENISCUS? (MACROCHEILUS) MEDIALIS, *Meek and Worthen.*

Plate 34, *figs.* 15 *and* 16.

MACROCHEILUS MEDIALIS, *M. and W.*, 1866. Illinois Geol. Reports, II, p. 370, pl. 31, fig. 5 a and 5 b.

Shell subovate; spire depressed-conical, its sides a little convex, but the apex is small and acute when entire; volutions six or more in number, those of the spire convex, increasing rapidly in size, the last one large, moderately ventricose; suture distinct, but not deep; outer lip thin and sharp at the margin, when unbroken; inner lip covered with callus, and having a moderately deep sinus at the middle, forward of which there is a tendency to form an obtuse fold; but it is not yet known to be continuous within the aperture with a sharp fold, such as all the species possess which have just been herein described; surface plain.

Length, 22 mm.; diameter of the last volution, 17 mm.

Locality. Meek and Worthen's examples were obtained from near Springfield, Illinois. The example figured on plate 34, is from Vermillion county, Indiana.

SOLENISCUS? (MACROCHEILUS) PONDEROSUS, *Swallow?*

Plate 34, *figs.* 1 *and* 2.

MACROCHEILUS PONDEROSUS, *Swallow*, 1858. Trans. St. Louis Acad. Sci., I, p. 202.

The example figured on plate 34 is from the Upper Coal Measures of Iowa, and is given here for comparison, in connection with the discussion of the shells just described. It has not yet been found in Indiana, but there is no apparent reason why it may not be found in the rocks of this State.

This shell, like the last described, is not known to possess a sharply raised fold within the aperture, but it has the deeply sinuous inner lip, and a broad obtuse thickening of the columella below it; in short, it has all the general characteristics of the more globose of the forms that have been referred to *Macrocheilus*, except, perhaps, a sharply raised columellar fold.

SOLENISCUS? (MACROCHEILUS) PRIMIGENIUS, *Conrad.*

Plate 34, *fig.* 3.

STYLIFER PRIMIGENIA, *Conrad*, 1835. Trans. Geol. Soc. Penn., I, p. 267, pl. 12, fig. 2.
MACROCHEILUS INHABILIS (Morton) *Norwood and Pratton*, 1855. Jour. Acad. Nat. Sci. Philad. III., p. 76, pl. 9, fig. 9a and b.
MACROCHEILUS PRIMIGENIUS, *Hall*, 1858. Geology of Iowa Part II, p. 720, pl. 29, fig. 11.

This shell is a somewhat common one in the Coal Measure rocks of Ohio, Indiana, Illinois, and Iowa. In form it resembles the *M. ponderosus* of Swallow, as it has just been identified, but it is regarded as specifically distinct. It differs still more widely from the *Soleniscus* type than either of the two forms that have just been noticed under the respective specific names *medialis* and *ponderosus*. There seems to be nothing upon the columella that is suggestive of a fold, although just behind the place at which such a fold should appear there is a distinct concavity which passes around the columella within the aperture. The test is thick, and there is a considerable accumulation of callus upon the inner lip, and the general characteristics of the shell are like those of the species that have already been noticed.

Genus BELLEROPHON, *Montfort.*

BELLEROPHON CRASSUS, *Meek and Worthen.*

Plate 33, *figs.* 1 *and* 2.

BELLEROPHON CRASSUS, *M. and W.*, 1866. Illinois Geol. Survey, II, p. 385, pl. 31, fig. 16.

Shell large, massive, subglobose; volutions gradually expanding laterally, broadly rounded upon the back, more abruptly rounded at the sides and into the umbilici, which are rather small; outline of aperture reniform, the transverse diameter being the greater; postero-lateral portions of the lip thickened and spread outward and backward over the inner volutions, and also partly over the umbilici; antero-lateral portions of the lip thinner than the others, their margins slightly convex on each side of the mesial notch; mesial band narrow; mesial notch distinct, but not deep; surface marked by distinct lines of growth, a part of which assume the character of somewhat irregular transverse wrinkles.

Diameter in the plane of the coil, 58 mm.; transverse diameter of the aperture, 50 mm.

Locality. This species is known to exist in both the Lower and Upper Coal Measures, and to range from Indiana to Nevada. It has been found in Sullivan and Posey counties, Indiana; but, there, only in the Upper Coal Measures.

BELLEROPHON PERCARINATUS, *Conrad.*

Plate 33, *figs.* 9, 10, 11, 12, 13 *and* 14.

BELLEROPHON PERCARINATUS, *Conrad*, 1842. Jour. Acad. Nat. Sci. Phil., VIII, pl. XVI, fig. 5.
BELLEROPHON PERCARINATUS, *Norwood & Pratten*, 1854. Jour. Acad. Nat. Sci. Phil., III, (U. S.), p. 74, pl. IX, fig. 4.

Shell subglobose; laterally expanded at the front; umbilici closed; outer lip thin at the front, thickened by callus at the sides; inner lip thickened by callus, which is sometimes in the form of a broad, prominent lobe, sometimes trilobed, and sometimes presenting only one narrow lobe, and that at the median line; the last volution is always marked by one strong, rugose or nodose median carina, which extends from the inner lip to the front margin; in most cases there is a more or less distinct revolving ridge at each side of the median carina, and of equal extent with it; the whole surface is also marked by strong transverse wrinkles and lines of growth, but sometimes the lateral ridges are wanting.

Length, 24 mm.; breadth, the same.

This is one of the more common of the shells of the Coal Measure rocks.

Locality. It has been discovered from coal M. throughout the Upper Coal Measures.

BELLEROPHON CARBONARIUS, *Cox.*

Plate 33, *figs.* 6, 7 *and* 8.

BELLEROPHON CARBONARIUS, *Cox*, 1857. Geol. Sur. Kentucky, III, p. 562.

Shell subglobose; dorsal side broadly rounded; umbilici very small, shallow; aperture arcuate, much wider transversely than in the plane of the coil; its border not expanding more rapidly than the uniform rate of increase in the size of the volutions; inner lip not developed as such, the accumulation of callus there being often imperceptible; outer lip thin along the median portion but thickened a little and having a rounded edge toward the umbilici; median sinus not deep, rounded at bottom; median band obscure upon the costate portion of the shell, but moderately distinct upon the outer, plain portion, where it is bounded upon either side by a more or less distinct raised line; the outer third, or more, of the last volution is plain, but the remainder is marked by from twenty to twenty-eight simple, distinct, narrow, revolving, raised ridges or costæ; the two or three nearest the umbilici are, near the plain portion, sometimes broken up into small, irregular nodes.

Diameter of the coil and transverse diameter nearly equal, each being about 17 mm. in the type specimen of Cox, which is figured on plate 33.

Formerly, authors generally referred this shell to the *B. Urii* of Fleming, and it is even now doubtful if we are justified in separating it fully

from that species. There are, in different parts of the wide range which this species has, several noticeable varieties, the differences being as to size and character of surface markings. One of these varieties, found in the Rocky Mountain region, I have thought of sufficient importance for separate specific designation as *B. subpapillosus*. The typical forms, however, have a range from West Virginia to Nebraska.

Locality. This species may be sought for throughout the Coal Measures of Indiana.

Bellerophon nodocarinatus, *Hall.*

Plate 33, *figs.* 3, 4 *and* 5.

Bellerophon nodocarinatus, *Hall*, 1858. Geology of Iowa, part II, p. 723, pl. XXIX, fig. 15, a, b, c.

Shell subglobose; somewhat expanded at the sides; umbilici closed; the smaller part of the last volution somewhat regularly rounded transversely, but upon the outer half of it there is a broad subnodose median carina, with a narrow, shallow furrow along its middle, and upon each side of the carina there is a broad, shallow depression; the inner half of the outer volution is marked by coarse, revolving, raised lines; outer lip thin; little or no callus upon the inner lip, sides of the aperture near the umbilici having thickened and rounded edges.

Diameter in the plane of the coil, 40 mm.; greatest transverse diameter, 37 mm.

This form is referred with doubt to the *B. nodocarinatus* of Hall, but it seems to present some important differences. It is also closely related to the form which I described from New Mexico under the name of *B. inspeciosus*. The latter shell is more expanded at the outer, and narrower at the inner, part of the last volution than the form here described; the carina is also not so well defined, nor is it nodose. It is probable, however, that both *B. inspeciosus* and the form here described will prove to be only varieties of *B. nodocarinatus*.

Locality. The form here described is from New Harmony, Indiana.

Genus Platyceras, *Conrad.*

Platyceras Nebrascense, *Meek.*

Plate 32, *figs.* 15 *and* 16.

Platyceras Nebrascensis, *Meek*, 1872. U. S. Geol. Sur. Nebraska, p. 227, pl. IV, fig. 15, a, b.

Shell small, elongate-conical, more or less curved, or sometimes subspiral; apex free, bluntly pointed, more or less curved towards the body of the shell and turned toward its dextral side; aperture irregularly oval; its margin thin, broadly sinuous behind and to the left of the apex

the remainder of the border usually having several other more or less distinct sinuosities; surface marked by more or less distinct lines of growth, which are parallel with the sinuosities of the border.

Length, 20 mm.; breadth of aperture, 12 mm.

This species was originally described from the Upper Coal Measures of Nebraska, but it has been found to range from Indiana to New Mexico.

Locality. It has been found at the following Indiana localities: Eugene, Edwardsport, and New Harmony.

Genus PLEUROTOMARIA, *Defrance.*

PLEUROTOMARIA TURBINIFORMIS, *Meek and Worthen.*

Plate 32, *figs.* 7 *and* 8.

PLEUROTOMARIA TURBINIFORMIS, *Meek and Worthen*, 1866. Illinois Geol. Reports, II, p. 359, pl. XXVIII, fig. 8, a, b, c.

Shell subpyramidal; spire moderately elevated; volutions five or more in number, flattened at the outer side, so as to produce nearly straight sides to the spire, the last volution prominently angular at the periphery, and broadly convex below; umbilicus small and bordered by an obscure ridge; spiral band situated at the peripheral angle of the volutions, very narrow, and bordered by slender elevated lines; surface of each volution marked by about twenty obscure, close-set, revolving striæ, which are crossed by stronger and more regular obliquely transverse lines; these lines curve backward near the spiral band.

Length and breadth, each, about 25 mm.

Locality. Upper Coal Measures, at Lasalle and Paris, Illinois, and in Vigo county, Indiana.

PLEUROTOMARIA TABULATA, *Hall.*

Plate 32, *figs.* 4 *and* 5.

PLEUROTOMARIA TABULATA, *Hall.* Geology of Iowa, Part II, p. 721, pl. XXIX, figs. 12, a, b.

Shell unusually elongate for a species of this genus; volutions eight or more in number, prominently angular, the angle situated at about the middle of the volution, and bearing a finely nodulated carina; umbilicus closed; columellar lip a little thickened; suture distinct; surface marked by numerous revolving raised lines which are a little coarser upon the anterior side of the last volution than elsewhere; these are crossed by lines of growth, which give the revolving striæ a more or less crenulated appearance; the striæ of growth bend abruptly backward to meet the peripheral angle, showing that the outer lip was notched at that point.

Length, 52 mm.; breadth of the last volution, 44 mm.

This species is known to exist in the Coal Measure strata from Indiana to Iowa. It was described and figured in the Indiana report for 1880, but it is reproduced here to bring all the Coal Measure shells together.

Locality. Upper Coal Measure strata, Rush Creek, Posey county; Wagon-defeat Creek, Sullivan county, and Warrick county, Indiana.

PLEUROTOMARIA SPHÆRULATA, *Conrad.*

Plate 32, figs. 1, 2 and 3.

PLEUTOMARIA SPHÆRULATA, *Conrad*, 1842. Jour. Acad. Nat. Sci. Philad., VIII, p. 272, pl. XVI, fig. 13.

Shell depressed, subturbinate; spire moderately extended, its sides straight or gently convex; apical portion truncated; volutions five or six in number, their outer surface flat, and bearing a tuberculated ridge at the distal border, adjacent to the suture; the last volution large, narrowly rounded or subangular at the periphery; its anterior side broadly convex; umbilicus closed; spiral band situated at the periphery, narrow and indistinct; surface marked by lines of growth which, on both sides of the spiral band, bend back to meet it, showing that the outer lip had there a broad and deep notch.

Length of a large example, 22 mm.; breadth of the last volution, 29 mm.

This is a somewhat variable shell, and also a widely distributed one. It has been found at various localities in the Carboniferous rocks, from Pennsylvania to Utah.

Locality. Horizon of coal K., and throughout Upper Coal Measures.

Genus EUOMPHALUS, *Sowerby.*

EUOMPHALUS RUGOSUS, *Hall.*

Plate 32, figs. 11 and 12.

EUOMPHALUS RUGOSUS, *Hall*, 1858. Geology of Iowa, Part II, p. 722, pl. XXIX, fig. 14.

Shell small, discoid; upper side concave; lower side flat or gently concave; volutions four or more in number, in contact but not embracing, the whole breadth of each being exposed both at the upper and under sides of the shell; obliquely flattened at the periphery, and bearing a narrow prominent ridge at the angle formed by the outer and upper sides; and another similar ridge at the junction of the outer and under sides, the latter being directed outward, and the former upward; aperture subcircular, and not conforming in outline to the two angles mentioned; surface marked by strong lines and wrinkles of growth, which give a

rough appearance to the shell, and especially to the two ridges as they cross them.

Diameter of the coil from 12 to 20 mm.

This, a very widely distributed and characteristic species of the Coal Measure strata, may be found from the lowest to the highest coals, culminating in the Upper Coal Measures.

Genus NATICOPSIS, *McCoy.*

NATICOPSIS NANA, *Meek and Worthen.*

Plate 36, *figs.* 6 *and* 7.

NATICOPSIS NANA, *M. and W.*, 1866. Illinois Geol. Reports, II, p. 365, pl. XXXI, fig. 4.

Shell small, subglobose, wider than high; spire much depressed; volutions about three in number, the last one large, and somewhat ventricose; suture well defined; aperture broadly subovate, somewhat straightened at the inner side, its length nearly equal to seven-eighths of the full axial length of the shell; outer lip thin; inner lip moderately thickened; surface marked by fine lines of growth, which are a little stronger and more uniform on the distal side of the volutions, near the suture, than elsewhere.

Length, 5 mm.; breadth, $4\frac{1}{2}$ mm.

This little species is known in the Carboniferous strata from Indiana to Nevada.

Locality. In Upper and Middle Coal Measures.

NATICOPSIS WHEELERI, *Swallow.*

Plate 32, *figs.* 13 *and* 14.

LITTORINA WHEELERI, *Swallow*, 1860. Trans. St. Louis Acad. Sci., I, p. 658.
NATICOPSIS WHEELERI, *Meek and Worthen*, 1873. Illinois Geol. Reports, V, p. 595.

Shell rather small, obliquely subrhomboidal in outline when laterally viewed; volutions four or more, the last one moderately gibbous and composing more than two-thirds the entire length of the shell; aperture subovate; test moderately thick; surface covered thickly with small, prominent tubercles, which, on the small volutions of the spire, are minute, but they increase in size with the growth of the shell; outer lip moderately thin; inner lip somewhat thickened with callus.

Length of a large example, 16 mm.; breadth of the last volution, 14 mm.

This species is a well marked one; and it has also a wide geographical distribution. It is known in the Coal Measure strata from Indiana to New Mexico.

Locality. Swallow's type specimens were obtained from the Coal

Measure strata of Missouri, and Meek and Worthen described and figured it from Illinois. It may be found in Upper Coal Measures of the western part of Vigo county.

Genus POLYPHEMOPSIS, *Portlock.*

POLYPHEMOPSIS PERACUTA, *Meek and Worthen.*

Plate 32, *figs.* 9 *and* 10.

POLYPHEMOPSIS PERACUTA, *M. and W.* Illinois Geol. Reports, II, p. 375, pl. XXXI, fig. 7, a, b.

Shell slender; spire long, attenuated, its sides gently concave; apex small and acute; volutions, twelve or more in number, flattened or very slightly convex at the outer side, the last one large and constituting about one-half the entire length of the shell, extended and somewhat contracted anteriorly; suture slightly impressed, but distinct; aperture narrowly subovate in outline; sharply angular behind, and somewhat effuse anteriorly; outer lip thin; inner lip flexed and a little thickened; surface plain, but, under a lens, fine lines of growth are seen.

Length, 45 mm.; breadth of the last volution, 13 mm.

This species is not a very common one. It is regarded as characteristic of the Upper Coal Measures.

Locality. The species was was originally published from the Upper Coal Measures of Illinois. It may be reasonably sought for at the following Indiana localities: Horizons of coals M. and N. of the Upper Coal Measures.

POLYPHEMOPSIS NITIDULA, *Meek and Worthen.*

Plate 27, *figs.* 7 *and* 8.

POLYPHEMOPSIS NITIDULA, *M. and W.*, 1866. Ill. Geol. Repts. II, p. 374, pl. XXXI, figs. 9, a, b.
POLYPHEMOPSIS NITIDULA, *White*, 1882. Eleventh Indiana Geol. Report, p. 370, pl. 42, figs. 7 and 8.

This shell was published in the Eleventh Annual Report, and referred, with some doubt, to the *P. nitidula* of Meek and Worthen. Our example is larger than the type specimen of Meek and Worthen, but it seems to be specifically identical. It is subfusiform; spire extended, its sides nearly straight; volutions eight or more in number, moderately convex, the last one rather large, constituting a little more than half the full length of the shell; suture impressed and distinct; aperture subovate in outline, angular behind; surface plain.

Length, 27 mm.; diameter of the last volution, 11 mm.

Locality. The type specimens of Meek and Worthen came from the Upper Coal Measures of Springfield, Illinois. The specimen here described and figured is from the Coal Measure strata at Eugene, Vermillion county, Indiana.

POLYPHEMOPSIS? ————?

Plate 32, *fig.* 6.

In the Indiana Geological Report for 1880, I figured and described this form as *Polyphemopsis fusiformis*, identifying it with the *Macrocheilus fusiformis* of Hall, at that time believing that species to be properly referable to *Polyphemopsis*. In the last particular, I was wrong; and I have, on a preceding page, included Professor Hall's species among those shells which have hitherto been referred to *Macrocheilus*, referring them all, provisionally, to *Soleniscus*.

The form here in question, I do not regard as certainly identical with the *Macrocheilus fusiformis* of Hall, nor am I confident that it properly belongs to the genus *Polyphemopsis*. I refer it here, provisionally, to the last named genus, but it is quite likely that it will hereafter be found to be congeneric with those shells which in this article I have referred to *Soleniscus*.

This shell comes from the Coal Measure strata at Newport, Indiana.

CEPHALOPODA.

Genus ORTHOCERAS, *Breynius*.

ORTHOCERAS RUSHENSIS, *McChesney*.

Plate 36, *fig.* 5.

Shell small, slender, cylindrical or terete; septa moderately concave; siphuncle subcentral; test finely and distinctly striate when the epidermis is not removed.

This is probably the species that was described by McChesney in his pamphlet entitled New Paleozoic Fossils. There are probably three or four small species of *Orthoceras* in the Carboniferous strata of the United States which are so near alike that it is difficult, and apparently unprofitable, to attempt to separate them. The species of this genus, at best, present few prominent specific characteristics. The figure on plate 36 will give a better idea of the character of the fossil in question than a description of it could do.

Locality. Eugene, Newport, Lodi, Merom, Graysville, New Harmony, Rush Creek, Newberg, Indiana, from coal A. to top of the Measures.

Genus NAUTILUS, *Breynius.*

NAUTILUS WINSLOWI, *Meek and Worthen.*

Plate 36, *figs.* 1 *and* 2.

NAUTILUS (TRMNOCHEILUS) WINSLOWI, *M. & W.*, 1873. Illinois Geol. Reports, V, p. 609, pl. XXXII, fig. 2.

Shell moderately large, subdiscoidal; umbilici broad and moderately deep, showing nearly the full size of each volution; peripheral side broadly flattened, the middle third being more distinctly flat than the remainder, and the sides sloping slightly to the lateral margins; volutions four or more, their transverse diameter about one-third greater than that of the opposite direction, the lateral margins of the volutions bearing each a row of prominent rounded nodes, which project outwards laterally; from the rows of nodes the sides slope inward with gentle convexity; surface marked by distinct lines of growth, which curve gently backward in crossing the sides of the volutions from the inner margin, and also curve strongly backward in crossing the periphery, indicating a broad mesial sinus in the outer lip.

Diameter of the coil, 125 mm.; transverse breadth near the aperture, including the nodes, 88 mm.

Locality. The type specimen of this species was obtained from the Coal Measure strata at Danville, Illinois. It may be sought for at the following Indiana localities: At horizons of coals M. and N.

NAUTILUS FORBESIANUS, *McChesney.*

Plate 36, *figs.* 3 *and* 4.

NAUTILUS FORBESIANUS, *McChesney.* Trans. Chi. Acad. Sci., I, p. 50, pl. III, fig. 4.

Shell somewhat massive; volutions in contact but not embracing; broadly convex on the peripheral side; abruptly rounded at each lateral portion, from which the sides slope abruptly into the umbilici; these are large, broad and deep, showing almost the whole width of each volution; transverse section of the volutions subelliptical, about half as wide in the plane of the coil as it is in the opposite direction; septa plain and moderately concave; siphuncle subcentral; a row of prominent rounded nodes occupies each side of the volutions, and where the shell substance is preserved, it shows close-set, coarse, revolving, raised lines which apparently covered the whole surface.

The full diameter of an adult shell is not known, but it probably reached as much as, or more than, 100 mm.

Locality. Prof. McChesney's type specimen was from Mercer county, Illinois. The one figured on plate 36, is from Newport, Indiana.*

* *N. decoratus*, Cox.

NAUTILUS MISSOURIENSIS, *Swallow?*

Plate 35, *figs.* 1 *and* 2.

NAUTILUS MISSOURIENSIS, *Swallow*, 1857. Trans. St. Louis Acad. Sci., p. 198.

Professor Swallow's description is incomplete, having been evidently based upon either a very small example or the inner volutions of one of larger size. Our example, although incomplete, is much larger than Swallow's specimen, but the characters which he mentions in his description induce me to refer it to *N. Missouriensis* rather than to propose a new name for it, or refer it to any other described species. It is certainly very closely related to *N. spectabilis* of Meek and Worthen (Illinois Geol. Survey, II, p. 308, pl. 25) of the Chester Limestone. Its proportions are similar, and its septa have a like gentle sinuosity, but it is apparently without the row of gently raised obtuse nodes at each side, which characterize *N. spectabilis*. This specimen being only a cast, and somewhat eroded, may really have possessed that feature. The principal objection to regarding our example as specifically identical with *N. spectabilis* seems to lie in the fact that it comes from another formation; but in view of the known intimate faunal relationship between the Chester Limestone and the Coal Measures, their specific identity does not seem improbable.

The full diameter of the coil of our example, when perfect, was not less than 80 or 100 mm.

Locality. Silverwood, Fountain county, Indiana.

CRUSTACEA.

The crustacean remains that have been discovered in all the strata of that great coal-field which includes a large part of the State of Indiana, are few, but they are interesting and important. If we were to regard the smallness of the number of species that have been recognized among these fossil remains as an indication of the prevalence of crustacean life during the Coal Measure period, our estimate would be a very low one. But the small number of species referred to embrace forms which differ widely from each other, and include representatives of four or five orders of the class *Crustacea*. Because of the great diversity of form and structure among these fossil remains of the Coal Measure period, we necessarily infer that crustacean life was not only abundant during that ancient period, but that it had then reached almost as wide a range of differentiation as it has at the present day.

The crustacean life of the Carboniferous age possesses peculiar interest for several reasons. In its strata are found the latest known examples of the Trilobites, that remarkable order of Crustaceans which under a multitude of forms prevailed so abundantly in all the previous geological

periods. In strata of later date than those of the Carboniferous age, these crustacean forms have never been discovered, and it is believed that the last of that order became extinct with the close of that age.

The earliest known representatives of the order to which the living horse-foot crab belongs are also found in Coal Measure strata; and with them are also found the earliest known representatives of the shrimps and cray-fishes of the present day. A few other forms are, also, occasionally found in these strata which, like the Trilobites, have ceased to exist, but they are few, and the last of their kind.

We thus find in the strata of the Carboniferous age, and especially in those of the Coal Measure period, a commingling of ancient and modern types of crustacean life. Old things were then passing away, and the new were introduced to supply their places. The same is true, also, with regard to certain other classes and orders of animal life, but not with reference to all, for the changes were gradual, and many important ones did not take place until much later periods.

The following descriptions, with their accompanying illustrations (the former considerably condensed), are copied, mainly, from the work of Messrs. Meek and Worthen upon the Coal Measure fauna of the adjoining State of Illinois, but it will not be unreasonable to expect to find any and all of them in the Coal Measure strata of Indiana.

GNATHOSTOMATA.

Genus LEAIA, *Jones.*

LEAIA TRICARINATA, *Meek and Worthen.*

Plate 39, *figs.* 10, 11, 12 *and* 13.

LEAIA TRICARINATA, *M. & W.*, 1868. Illinois Geol. Rep., Vol. III, p. 541.

The carapace valves of this species are transversely oblong, the length being somewhat more than one-quarter greater than the height, but these proportions vary in different specimens; the anterior border rounded; basal margin broadly convex; posterior margin truncated, nearly straight and usually nearly perpendicular, but, sometimes, oblique, and meeting the dorsal margin at a slightly acute angle; dorsal margin straight, and the dorsal border of each valve is bent abruptly in at right angles with the plane of the valves, thus forming a well defined lanceolate corselet, which is margined at each side by a slender carina; the lateral radiating ridges, slender, sharply defined, and diverge from each other at an acute angle; the posterior one is the longer of the two, straight, and extends to the postero-basal margin; the anterior one is a little curved, and passes from the beak to the antero-basal border; the surface is marked by from twelve to sixteen minute, slender, raised striæ, which run parallel to the posterior and anterior margins respectively.

Length of one of the larger examples, about four-tenths of an inch; height, a little less than three-tenths; and the thickness, both valves together, nearly one-fifth of an inch.

Examples of this interesting bivalve crustacean have been found at various localities in the Coal Measure strata. It is usually so compressed in shale or other rock as to flatten the valves almost completely and obscure the portion which is flexed inward at the dorsal border to form the dorsal corselet. Meek and Worthen, however, obtained some specimens which were uncompressed. The test was very thin, and is usually not preserved upon the specimens. Upon casts of the inner surface of the valve an impressed line shows the position of each radiating ridge, and a similar and much more slender one shows the position on the outer side of each of the delicate, concentric, raised lines.

This form resembles the *Leaia leidyi*, Lea, from Pennsylvania, but Meek and Worthen regard them as quite distinct. These differ from *L. leidyi* in being about twice as large, in having the posterior margin more oblique, the basal margin more convex, and the radiating ridges more sharply defined. The shell is also shorter in comparison with its width.

Locality. Patty's Ford of Little Vermillion River, west of Eugene, Brouillet's Creek, Vermillion county, Indiana.

MEROSTOMATA.

Genus EURYPTERUS, *DeKay.*

EURYPTERUS (ANTHRACONECTES) MAZONENSIS, *Meek and Worthen.*

Plate 37, *figs.* 1, 2 *and* 3.

EURYPTERUS (ANTHRACONECTES) MAZONENSIS, *M. and W.*, 1868. Am. Jour. Sci., XLVI (2), p. 21; Ib., 1868, Illinois Geological Reports, III, p. 544.

Only one specimen of this interesting fossil has yet been found, and it is the only known representative in this country, found in the Carboniferous strata, of an interesting order of *Crustacea* that seems to have reached its culmination in the Upper Silurian age. Some of those whose remains have been found in the Waterlime Group of New York were monsters—one of them seems to have been not much short of three feet in length, according to the statements of those authors who have described them.

This carboniferous specimen consists of an impression upon the split surface of an iron-stone nodule. It shows the under surface of all the thoracic segments, and a part of one or two of those of the abdominal series; also the operculum or thoracic flap, the post-oral plate, and the maxillary or basal joints of the swimming feet, all in place. All these parts are in a more or less unbroken condition, but they have been flat-

tened by pressure. There are, also, imprints of some of the succeeding joints of one of the swimming feet, and its oar-like expansion; some obscure impressions of three of the smaller legs on one side, and some of the basal joints of their fellows upon the other side. All these organs converge toward the mouth, the position of which is immediately in front of the post-oral plate. The legs are slender, terminate in a long sharply pointed dactylus like that of the legs of *Pterygotus*, and appear to be without any lateral spines. The carapace, dorsal portions of the thorax, the posterior portions of the abdomen and the telson are unknown.

The post-oral plate is about three-quarters of an inch in length, and eleven-twentieths of an inch in breadth, at the widest part, which is a little behind the middle. It is subovate in outline, broadly rounded at the sides, more narrowly rounded at the ends, the anterior end being distinctly emarginate at the middle. The maxillary joints or plates of the swimming feet expose a subtrigonal outline, their length being a little more than three-fifths of an inch, and their breadth, at the posterior margin, seven-tenths of an inch. Their lateral slopes are slightly sinuous along the middle, while their anterior ends are narrow, pointed, incurved, and hardly project beyond the anterior end of the post-oral plate. The succeeding joints are distinguishable upon the specimen, but they are not sufficiently well preserved to allow of satisfactory description.

The breadth of the thorax, near the middle, is nearly two and a half inches, and a little more than two inches in length. On the ventral side the middle segments are a little more than seven-tenths of an inch in length or antero-posterior diameter; but both the anterior and posterior ones, especially the latter, are shorter; and they are all rounded at their postero-lateral angles. Some impressions upon the surface of the specimen, however, show that the lateral terminations of the dorsal portion of the posterior thoracic segments extended out beyond the rounded ends of those below, into acutely pointed extremities, directed obliquely outward and backward. These projecting points of one of the posterior thoracic segments are seen to extend out obliquely nearly half an inch beyond the rounded extremities of those below, and to terminate in sharp points. A portion of one of the anterior abdominal segments which remains, appears to show that the abdomen is comparatively narrow, and that the postero-lateral extremities of its segments terminate in strong angular processes, directed nearly straight behind, but having oblique anterior margins.

The thoracic flap has lateral wings similar to those of the typical forms of *Eurypterus*, and they have the appearance of being composed of two of the body segments anchylosed together, the anterior one being not more than half as broad as the other, which is of the same size as the body segments. Its mesial appendage has the remarkable length of one and six-tenths inches, and can be traced on the specimen as far back as the posterior margin of the fifth thoracic segment, and it is evidently not

bipartite at the extremity. On each side of the anterior end of the mesial appendage there is a small spatulate piece which does not correspond to any known parts of the operculum of the *Eurypterus*. These pieces are a little more than four-tenths of an inch in length and three-twentieths of an inch in breadth. Their sides are nearly parallel, anterior extremities pointed, and their posterior ends transversely truncated with their lateral angles rounded. Their anterior pointed ends terminate nearly in contact with the two small pieces called intercalated pieces, by Prof. Hall.

In consequence of the differences which this species presents from the typical forms of *Eurypterus*, Meek and Worthen suggested that it might be found to be generically, or at least subgenerically, distinct. The differences they designated are the great length and non-bipartite extremity of the mesial appendage of the operculum, and the presence of an additional spatulate appendage at each side of the long mesial one.

Locality. This specimen was obtained from the Coal Measure strata at Mazon Creek, Grundy county, Illinois. It may reasonably be sought for at the following localities in Indiana: Patty's Ford of Little Vermillion River, Brouillett's Creek, Vermillion county, and Durkee's Ferry, Vigo county.

Genus EUPROOPS, *Meek and Worthen.*

EUPROOPS DANÆ, *Meek and Worthen.*

Plate 39, *fig.* 1.

BELLINURUS DANÆ, *M. and W.*, 1866. Illinois Geol. Report, II., p. 395.
EUPROOPS DANÆ, *M. and W.*, 1868. Illinois Geol. Report, III., p. 547.

This interesting ancient representative of the living horse-foot crabs was first described under the generic name of *Bellinurus*, and by that name it became somewhat widely known. Upon the discovery, however, of better examples than were at first known, Meek and Worthen found that it possessed certain characteristics which are not shown by *Bellinurus*. They, therefore, proposed the genus *Euproops* to receive it.

The cephalo-thoracic shield is transversely crescentic in outline, more than twice as wide as long, moderately convex, its height nearly equal to half its length at the median axis; the front margin, including the spine-bearing sides, continuously and regularly rounded; the lateral angles directed obliquely outward and backward with a slight curve, the convexity of which is outward; these angles end in slender acute spines, their points being nearly opposite the middle of the abdomen, and at some distance from its sides; the posterior margin of the cephalo-thoracic shield nearly straight along the middle portion, and gently concave at each lateral portion; mesial lobe small, a little less in height than the adjacent ocular ridges, rounded and well defined at its posterior end, where it bears

a central tubercle, which is probably sometimes spine-like; at about one-third the length of the shield from the posterior margin, a less distinct tubercle sometimes appears; the sides of the lobe converge gently forward, then they suddenly converge into a linear carina, which extends forward to the anterior transverse division of the ocular ridge; the area which is included by the ocular ridge is subquadrangular in outline or crown-shaped, and constitutes the middle third of the cephalo-thoracic shield; at its anterior end it is a little wider than its full length, which is equal to about five-sixths the length of the shield; its lateral margins concave; anterior side convex, with a central emargination; its surface is divided into four irregular areas by the mesial lobe with its anterior linear prolongation, and the two less distinct linear transverse ridges; ocular ridge narrow, but distinct, its lateral portions arching inward behind the eyes, and terminating posteriorly at the margin of the shield, nearly opposite the middle of each lateral lobe of the abdomen, in a spine-like process which appears to have been triangular, the process being directed backward, outward and a little upward; the anterior transverse division of the ridge arching forward at each side, and curving backward at the middle. Compound eyes small, distant from each other, and located one at each antero-lateral angle of the crown-shaped central area of the shield, about one-third its length from its anterior margin. Simple eyes are not known to have existed. The abdomen is transversely suboval in outline, wider than long; the lateral margins rounded in abruptly at the front, but, posteriorly, they blend into a regular curve with the posterior margin; the surface of the abdomen a little more depressed than that of the cephalo-thorax, especially in front; the flattened lateral borders are rather narrow, and scalloped between the marginal spines; the breadth of the mesial lobe about equal to that of the cephalo-thoracic lobe, a little more elevated than the lateral abdominal lobes, and half as broad; segments distinct, the first and third, each, bearing a small tubercle, the sixth as long as any of the others, narrowed and depressed behind and bearing a large tubercle, which is apparently sometimes spine-like; lateral abdominal lobes, depressed along the inner side, rounding abruptly down to the flattened free borders at the outer sides and behind; segments defined by linear ridges, which are separated by flattened spaces four or five times as wide as the ridges; the latter extend obliquely outward, and a little backward, across the lateral lobes and their flattened borders, and are produced into the slender lateral spines, which have a gentle backward curve.

The telson is apparently nearly two-thirds as long as the abdomen, gradually tapering, subtrigonal, flat below, angular at each side, and obtusely angular above.

The appendages of the under side unknown, except one leg. This is seen, in one specimen, projecting out from under the cephalo-thoracic

shield, between its posterior margin and the abdomen. The leg is slender; about one-eighth of an inch in length of the first segment appearing from beneath the shield; the next segment about one-quarter of an inch long and scarcely more than one twenty-fifth of an inch in breadth. The succeeding segments are traceable upon the specimen nearly one-third of an inch, curving toward the extremity, and apparently ending in a point. The position of this leg in the series has not been ascertained.

The entire length of the animal, from the extremity of the caudal segment to the anterior border of the cephalo-thoracic shield, is nearly two inches. Length of the cephalo-thorax, nearly six-tenths of an inch; breadth of the same, to the extremities of the lateral spines, one and seven-tenths inches; length of the area included by the ocular ridge, half an inch; greatest breadth of the same (the distance between the eyes), six-tenths of an inch. Length of the abdomen, nearly five-sixths of an inch; breadth of the same, excluding the flattened free margins, a little more than nine-tenths of an inch; breadth of the mesial lobe, nearly a quarter of an inch; length of caudal segment, six-tenths of an inch.

Locality. The type specimens of this species were found at Mazon Creek, Grundy county, Illinois, but they may be sought for in the following localities in Indiana: Brouillett's Creek and Durkee's Ferry, Vigo county.

Euproops Colletti (n. s.)

Plate 39, *fig.* 2.

On the face of a split iron-stone nodule found in Coal Measure strata at Durkee's Ferry, Vigo county, Indiana, there is an imperfect impression of an *Euproops*, which seems to be specifically different from *E. Danæ*. The specimen is too imperfect for detailed description, and it is, therefore, not attempted. It seems to differ from *E. Danæ* in the following particulars:

The cephalo-thoracic shield is proportionately a little larger, and, although its postero-lateral extremities are sharply angular, they appear not to have been produced into slender spines. The median lobe is wider in front, and it narrows more rapidly posteriorly, and with straighter sides. The caudal spine appears to have been smaller. The lateral spines appear to have been less slender, and the two last ones seem to have been very small and very close to the caudal spine.

Assuming this form to be distinct from *E. Danæ*, the proposed new specific name is given it in honor of Mr. Josephus Collett, who discovered it.

TRILOBITA.

Genus PHILLIPSIA, *Portlock.*

PHILLIPSIA (GRIFFITHIDES?) SCITULA, *Meek and Worthen.*

Plate 39, figs. 6, 7, 8 and 9.

PHILLIPSIA (GRIFFITHIDES?) SCITULA, *M. and W.*, 1873. Illinois Geol. Reports, V, p. 615, pl. XXXII, fig. 3.

As has already been stated, the great order of *Trilobites* became extinct with the close of the Carboniferous age. With the close of the Devonian age, the order became reduced to two or three genera, at most; and in the Coal Measure period, only a few examples of one or two genera are found. Only the two small species which are here described are likely to be found in the Coal Measures of Indiana, yet it is possible that others may yet be discovered.

This species is small, and, when distended, its outline is nearly elliptic. The cephalic shield is semi-elliptic, prominently convex, its breadth about one-third greater than its length; its anterior margin rounded; its posterior margin nearly straight; its postero-lateral angles projecting backward, and forming somewhat strong carinated, sharp spines, their points reaching as far back as the fifth thoracic segment. The glabella is broadly rounded, sloping in front, without an anterior projecting marginal rim; contracted toward its posterior end, which is the most elevated part; its prominent convexity defines it from the cheeks at either side, and it is also bordered, laterally, by a shallow furrow, which becomes obsolete around its front margin; postero-lateral lobes, comparatively large, sub-trigonal, very oblique, depressed, and distinctly defined by the lateral furrows in front; second and third lateral lobes small, transverse, indistinctly defined by short, nearly obsolete, linear furrows; anterior lobe larger than all the remaining portions of the glabella between it and the neck furrow. The neck segment is a little more prominent at the middle than the glabella, strongly arched upward but not forward, its antero-posterior breadth more than twice as great as that of one of the thoracic segments; a minute tubercle is usually observable upon its median line; neck furrow deep, broad, and corresponding to the arching of the neck segment. Eyes comparatively large, half as long as any part of the glabella, prominent behind, the position of their posterior margins opposite the neck furrow, and reaching forward less than half their own length beyond the posterior margins of the cheeks; the visual surface prominent, subhemispherical, smooth, and even appearing to be polished, under a pocket lens. When examined by a high magnifying power, however, it shows numerous regularly disposed minute lenses beneath the smooth, transparent outer layer; palpebral lobes semicircular, convex, and having the appearance of eye-

lids. Cheeks small in comparison with the eyes and glabella, and slope abruptly from the eyes into the deep, broad marginal furrow; the furrow suddenly becoming obsolete at the anterior lateral margin of the glabella, but extends backward to the subspiniform appendages; posterior margins having an elevated rim, strongly defined by the deep continuation of the neck-furrow; lateral margins, when viewed from above, showing a narrow rim, which, by side view, is seen to be deep, vertically flattened, and marked by fine parallel longitudinal striæ; anteriorly, the rim continues around to the front of the glabella, but it is not sufficiently prominent to be visible from above, and its upper margin is continued in the form of a carina, along the middle of the spinous processes, to their points. Facial sutures, cutting the anterior border in front of the eyes and the posterior margins of the cheeks behind the outer margins of the eyes.

Thorax almost as long as the head, but it is a little narrower, and distinctly trilobate; its mesial lobe prominent, convex, and a little wider than the lateral lobes; its nine segments narrow and subangular. The lateral lobes are depressed, convex, and flattened along their inner sides, sloping abruptly at their outer sides, producing, thus, an obtuse longitudinal angle along each lateral lobe; segments of the lateral lobes, six in number, simple, bent abruptly downward at the middle, where each has a minute pustule, but terminating abruptly at the rather wide border. Surface of the glabella and all the segments more or less granular, the granules being coarser on the posterior part of the glabella and neck segments than elsewhere.

Entire length of a medium sized example, nearly seven-tenths of an inch; length of the pygidium, two-tenths of an inch; breadth of the same, three-tenths; length of thorax, a little less than two-tenths; breadth of the same, a little less than three-tenths; length of the cephalic shield, two and a half tenths; breadth of the same, a little over three-tenths.

Locality. This species is widely distributed in those States which embrace portions of the Coal Measures. It may be found in the following places in Indiana, among others: Perrysville, Eugene, Lodi, Silverwood, and Newport.

PHILLIPSIA (GRIFFITHIDES?) SANGAMONENSIS, *Meek and Worthen.*

Plate 39, *figs.* 4 *and* 5.

PHILLIPSIA (GRIFFITHIDES?), SANGAMONENSIS, *M. and W.*, 1873. Illinois Geol. Reports V, p. 615, pl. XXXII, fig. 4.

This species resembles the foregoing in general aspect, but it is larger. It is subovate in entire outline, as indicated by the detached parts that have been discovered. The cephalic shield is convex, its outer border forming more than a semi-circle, about one-third wider than long, regularly rounded in front and straight behind, but its postero-lateral angles

are produced into strong carinated subspinous processes, which are equal in length to the distance from the posterior side of the cheeks to the anterior end of the eyes; glabella prominent, sub-inflated, defined from the cheeks, at each side, by a moderately distinct furrow, which is continuous around the front; its greatest convexity behind the middle, from which part it declines to the rounded front; its length is about one-fourth greater than its width, which is slightly greater between the eyes than it is further forward; the sides are nearly parallel, but a little sinuous along the middle; posterior lateral lobes, comparatively large, prominent, and isolated by the distinct lateral furrow which passes obliquely across, with a lateral curve, from opposite the middle of each eye, so as to intersect the neck furrow; second lateral lobes obscure and much smaller than those behind, defined by a faintly impressed curved oblique line; forward of these lobes there are also obscure traces of two other short obsolete lateral furrows which are hardly visible to the naked eye. Occipital segment well defined but shorter than the glabella, strongly arched upward but not forward, and projecting backward a little behind the range of the posterior border of the cheeks; neck furrow distinct and arched upward with the occipital, or neck segment; its prolongation along the posterior sides of the cheeks very deep and nearly straight for about two-thirds of the way across, towards the lateral margins, where it intersects another furrow, which passes around the sides of the cheeks.

Eyes lunate, rather large, or nearly half as long as the glabella, exclusive of the neck segments; they are prominent, being about as much elevated as the glabella, and their position is about half their own length in front of the posterior margins of the cheeks. The visual surface is smooth, and has a polished appearance under a pocket lens, but no traces of lenses have yet been detected in the eyes by a higher magnifying power. The palpebral lobes are convex, and rest upon the eye like a lid. The cheeks are subtrigonal, sloping abruptly away from the eyes; lateral margins turned downward, and forming a sharp edge below, which is continued backward along the postero-lateral spines. Above this there is a vertically flattened, or sometimes slightly concave, zone, which extends from near the front of the gabella, around the outer side of each cheek, and, passing backward, it becomes a shallow furrow upon the spines, traceable nearly to their extremities. Between this zone and the eyes there is another somewhat similar zone, which extends posteriorily around each cheek, from near the front, and unites with the lateral connections of the neck furrow behind; they then continue, as a single furrow, along the upper margin of the spines, and leave a more or less defined mesial ridge between these two furrows along the entire length of the spines, as well as around the cheeks, to near the front of the glabella; posterior margins of the cheeks behind the neck furrow prominent.

Facial sutures extending obliquely forward and outward from the ante-

rior side of the eyes, then curving inward, so as to cut the anterior margin nearly on a line with the anterior inner extremity of the eyes; from the posterior end of the eyes the sutures are directed outward and backward, intersecting the posterior margin about midway between the neck segment and the spine-like postero-lateral projections.

Thorax not fully known, only a few of the posterior segments having been discovered. These show the mesial lobe to be wider and more prominent than the lateral lobes; the latter lobes are flattened near the mesial lobe, and along the median line of each they are abruptly bent downward; segments divided by a furrow, which extends from the knee inward, along the anterior side.

The pygidium is semi-elliptic in outline, somewhat convex, and a little wider than long, narrower and a little longer than the cephalic shield, narrowing posteriorly, and abruptly rounded at the posterior extremity. Mesial lobe prominent, a little flattened at each side, narrower than the lateral lobes, separated from them at each side by a broad, strong furrow; the lobe tapers gradually backward, and terminates abruptly at a distance equal to about one-third its own length from the posterior margin; a broad, nearly flat, or gently sloping smooth border extends continuously along the whole free margin of the pygidium, which is a little broader at the posterior extremity than it is nearer to the abdominal portion; segments of the mesial lobe seventeen or eighteen in number, straight, rounded, and well defined.

Lateral lobes less prominent than the mesial, and one-third or one-fourth wider, abruptly convex at their outer side; segments nine or ten, simple, separated by distinct furrows, all terminating abruptly at the inner edge of the broad, smooth, marginal zone. The whole surface of the test nearly smooth.

Length of cephalic shield along the median line nearly half an inch; breadth of the same, six and a half tenths of an inch. Length of the glabella, three and a half tenths of an inch; breadth of the same, three-tenths of an inch at the widest part.

Locality. This species is not so commonly found as the preceding one, but it may be sought for at the same Indiana localities as the foregoing.

ISOPODA.

Genus ACANTHOTELSON, *Meek and Worthen.*

ACANTHOTELSON STIMPSONI, *Meek and Worthen.*

Plate 37, *figs.* 4 *and* 5.

ACANTHOTELSON STIMPSONI, *M. and W.*, 1866. Illinois Geol. Reports, II., p. 401, pl. XXXII, fig. 6.

ACANTHOTELSON STIMPSONI, *M. and W.*, 1868. Illinois Geol. Reports, III., p. 549.

Our present knowledge of this interesting species has been gained from

several successive discoveries of more or less imperfect examples, and the successive publications of it by the authors above cited have varied somewhat as additional knowledge was gained. The following is a summary of its characteristics:

Elongate or sublinear in shape; the upper antennæ fully as long as, if not longer than, the head and first five thoracic segments together; peduncle rather stout, a little longer than the head; first joint a little longer and wider than the two others, the latter being nearly of equal length; flagellum slender and minutely jointed; accessory appendage about as long as the flagellum and, like it, minutely jointed; inferior antennæ as long as the head and seven thoracic segments together; peduncle a little longer and larger, but, in other respects, it is like that of the upper antennæ; flagellum similar to the upper pair, but a little larger. Head apparently subquadrangular, its upper side longer than the lower, the anterior side being oblique. Eyes small, round, situated just below the bases of the upper antennæ. The thoracic and abdominal segments, together, fourteen in number, all distinctly observed, except the last one; a few of those nearest the head are a little shorter than the others, but, except this, they are all of nearly equal length; their antero-basal margins rounded; posterior margins subrectangular.

The thoracic legs of the first pair are about one-fourth longer and a little larger than those of the five succeeding pairs, and seem to end in a sharp dactylus. The five succeeding pairs of legs are of nearly equal size and form, and their upper segments are short and not enlarged. The seventh pair are nearly as long as the first, and more slender than any of the others. Abdominal natatory appendages long and slender, the styliform pair having the first segment short and quadrangular; second and only other joint as long as the telson, which they closely resemble in shape, their upper and lower margins each with a row of short oblique rather distant setæ, between which a good lens reveals numerous close-set minute setæ. Length of the telson equal to the length of the last four abdominal segments; its vertical width at the base equal to one-half the width of the penultimate abdominal segment, but it tapers to a mucronate point; upper and lower margins setigerous like those of the stylets.

Locality. All the specimens yet found are from Grundy county, Illinois, but it may be sought for at the following localities in Indiana: In concretions on Little Vermillion river and Brouillett's Creek of Vermillion county, and Durkee's Ferry in Vigo county.

Acanthotelson, Eveni, *Meek and Worthen.*

Plate 38, *figs.* 4, 5, 6, *and* 7.

Acanthotelson Eveni, *M. and W.*, 1868. Illinois Geol. Reports, III, p. 551.

All the specimens of this species that have yet been discovered are

fragmentary, but Meek and Worthen were satisfied that it is a distinct species from *A. Stimpsoni*. The differences which they pointed out are: That it is larger and more robust, while its body is proportionally longer and more slender. The joints of all the legs, and also of the antennæ, are proportionally longer and more slender. At first, these authors supposed that the stylets were not connected with penultimate, but with the antepenult segments. In their latest publication (*loc. cit.*) they express the opinion that the appearance just mentioned was deceptive, and produced by a displacement of the parts in their specimen during the process of its fossilization.

Locality. This form was discovered in Grundy county, Illlinois, associated with the preceding and other crustacean species, and is likely to be found in any of the Indiana Coal Measure strata that contain similar crustacean forms.

Genus DITHYROCARIS, *Scouler.*

DITHYROCARIS CARBONARIUS, *Meek and Worthen.*

Plate 39, *fig.* 3.

DITHYROCARIS CARBONARIUS, *M. and W.*, 1873. Illinois Geol. Reports, V, p. 618, pl. XXXII, fig. 1.

This species is yet known only by the caudal appendage; but this is so characteristic as to render its identification an easy matter by any collector. It is especially interesting as being the only representative of the genus which American strata have afforded.

The telson and stylets are lanceolate in shape and flattened. All three are closely similar in shape and size, but the telson is a trifle shorter than the stylets, and tapers to the extremity a little more rapidly. The telson is flattened upon its under side, and bears a faint mesial longitudinal ridge, with a faint longitudinal sulcus at each side of it; the lateral margins sharp. Its upper side bears a distinct mesial carina, from which the surface at each side slopes with gentle concavity to the sharp edges. The stylets are flattened upon their under side, where six or seven longitudinal ridges are seen. On the upper side, there is a distinct mesial longitudinal carina, with a concave furrow at each side of it. Along each lateral margin, there are two closely approximate carinæ, one above and the other below, with a narrow sulcus between.

Length of the telson, three-quarters of an inch; greatest breadth nearly one-eighth of an inch. The stylets are a trifle longer, and of the same breadth.

Locality. The original specimen of this species were found in Coal Measure strata at Danville, Illinois. It is a rare species, but it may be reasonably sought for in almost any of the Coal Measure localities in Indiana.

MACROURA.

Genus PALÆOCARIS, *Meek and Worthen.*

PALÆOCARIS TYPUS, *Meek and Worthen.*

Plate 38, *figs.* 1, 2, *and* 3.

ACANTHOTELSON INÆQUALIS, *M. and W.* Illinois Geol. Rep., II, p. 403, pl. XXXII, fig. 7.
PALÆOCARIS TYPUS, *M. and W.* Illinois Geol. Rep., II, p. 405, pl. XXXII, fig. 5.
PALÆOCARIS TYPUS, *M. and W.* Illinois Geol. Rep., III, p. 552.

Upon the original discovery of the first example of this form, Meek and Worthen believed it to belong to the genus *Acanthotelson*, and accordingly placed under the *Isopoda;* but upon the subsequent discovery of other and more perfect specimens, they established the new genus *Palæocaris*, and placed it with the *Macrourans.*

The body, in general shape, is linear, the thorax being slightly wider near its middle than the abdomen, the length of the segments nearly equal in both thorax and abdomen, the length of the inner antennæ about equal to that of the head and thorax together, the peduncles stout, the first joint of it being a little longer and wider than either of the other two; the latter joints are of nearly equal length and their inner borders are margined with fine, close-set setæ; the flagellum very slender and minutely jointed; accessory appendage about as long as the flagellum, which it closely resembles in all respects.

The outer antennæ appear to be a little longer than the others, and the peduncles slightly longer than those of the other pair, and they are also minutely setigerous in front; basal scales (?) oblong, squarely truncated, and about equal in length to the first joint of the peduncles.

The thoracic legs are long and slender, the anterior ones apparently not differing in this respect from the others; none appear to be chelate; the first two or three joints short, the fourth (?) joint tapering and extended horizontally, its length being about equal to four body segments; the succeeding joints slender, and bent abruptly downward and backward. Swimming appendages of the abdomen acutely lance-linear, the length of some of them being equal to four abdominal segments; base of the telson nearly as broad as the penultimate segment; the telson tapering at the sides, which are minutely setigerous, its length equal to two and a half abdominal segments; first joint of the stylets minute; the second lance-linear, each division being as long as the telson; extremities pointed; margins parallel and setigerous.

The ridge and proportions of the parts are given by the figures on plate 38.

Locality. This form, like most of the known crustaceans of the American Coal Measures, was obtained from the strata in Grundy county,

Illinois. It may be sought for at the following localities in Indiana: Patty's Ford of Little Vermillion River and Brouillett's Creek in Vermillion county, and Durkee's Ferry, Vigo county, in iron stone concretions, above coal L.

Genus ANTHRAPALÆMON, *Salter.*

ANTHRAPALÆMON GRACILIS, *Meek and Worthen.*

Plate 38, *figs.* 8 *and* 9.

ANTHRAPALÆMON GRACILIS, *M. and W.*, 1865. Proc. Acad. Nat. Sci., Phil., p. 50.
ANTHRAPALÆMON GRACILIS, *M. and W.*, 1866. Ill. Geol. Rep., II, p. 407, pl. XXXII, fig. 4.
ANTHRAPALÆMON GRACILIS, *M. and W.*, 1868. Ill. Geol. Rep., III, p. 554.

Successive discoveries caused Meek and Worthen to modify somewhat their first published descriptions of this species. The following is a summary of its structure, as now understood:

Carapace oblong in form, as seen by upper view, but the lateral margins are gently convex, the two extremities truncated, and its breadth about equal to three-fourths its length. Its lateral margins, forward of the middle, each bear six small, sharp serrations, like those on the type of the genus, but they are sharper, and are directed more obliquely forward. At each antero-lateral angle, there is, also, as in the type species, a larger, projecting, short spine, but this is turned more directly forward. The outer pair of antennæ moderately stout; each peduncle with three joints, which diminish gradually in size, the first longer than wide, and the other two of nearly equal length and breadth, and obliquely articulated. The flagellum is narrower at its base than the last joint of the peduncle, composed of very short segments, about one-third as long as wide. The antennæ were long and slender, but their full length is not known. Inner antennæ unknown.

The figures on plate 38 give the shape and proportions of all the other known parts.

Locality. The only known examples are from Grundy county, Illinois, but the species may be sought for in the same localities as the foregoing.